RETHINKING THE NETWORKED CITY:
THE (CO-)PRODUCTION OF HETEROGENEOUS WATER SUPPLY INFRASTRUCTURE IN NAIROBI, KENYA

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ERKLÄRUNG ZUR DISSERTATION

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M.Sc. Elizabeth Kanini Wamuchiru

To humanity

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ABSTRACT

Water supply is an integral infrastructure that sustains urban life. It is for this reason that urban planning authorities and state actors have for long pursued the provision of water services through a standardized infrastructure system that conforms to 'modern' and 'progressive' ideals. As such, the 'networked city', a Western technological ideology of the Nineteenth Century has remained the blueprint for planning and development of water infrastructure across the Globe. The 'modern' planning model presupposes a centralized governed and uniform urban configuration for the provision of networked infrastructures for the supply of urban services such as water, sewer, electricity and telecommunication. However, the networked city ideology presents limited perspectives in the production of variegated socio-technical arrangements for water supply in many contemporary cities. This is particularly the case across rapidly transforming post-colonial cities of the Global South. The pronounced visibility of water trucks, hand cart pullers, long queues at water vending kiosks, exposed water pipes and the ubiquitous 20-litre jerry cans dotting the urban street depict, rather vividly, the everyday unequal struggles to improvise reliable water supply across different cities of the Global South. The reliance on interactions of numerous modes of water supply to sustain urban life is a clear indication of multiple modernities that defy simplistic Western universalization around the 'modern' ideal of centralized and networked infrastructure systems.

This PhD study employs a socio-technical approach in analyzing the existing water supply modalities in contemporary cities of the Global South. Through an interpretative case study of Nairobi, Kenya, the study illuminates the interrelations between the networked water infrastructure run by the public utility company on the one hand, and the multiple non-networked water infrastructure models such as privatized enclave infrastructures, water vending practices, private boreholes and rain water harvesting on the other across different socio-spatial typologies in Nairobi. The study interweaves situated urban development processes of rapid socio-spatial transformations, development of residential enclaves, informal settlements and peri-urban sprawl with the wider political economy dynamics shaping water infrastructure provision. The recurring themes is that of localized socio-spatial processes that shape and are in turn shaped by circulating conventional planning models enforced by city authorities to produce unequal geographies of water supply across different parts of Nairobi. This is demonstrated through comprehensive empirical accounts drawn from four different neighborhoods namely, Eastleigh (fast transforming residential-cum-commercial inner city district), Runda (a gated residential neighbourhood), Kayole Soweto (a rapidly transforming informal

settlement) and Ruai (a peri-urban district). Each of the cases presents different socio-economic and political realities on the ground that contradict city authorities' visions of building an integrated 'modern' monolithic infrastructure system. Altogether, the four empirical cases help to ground the need for co-existence, co-production and co-governance of a heterogeneous infrastructure configuration, with the aim of broaching the inadequacies of centralized infrastructure systems across fast transforming 21st century cities.

The interrelations and multiplicity of infrastructure interpretations as I suggest for Nairobi, relate closely with contexts characterized by either lack of a centralized service, intermittent supply and/or multiple modalities of water supply as is the situation in many cities of the Global South. The study findings reveal that no one infrastructure model works in isolation without interacting with other configurations in both complementary and conflicting ways. It is also clear that different urban actors ranging from the public utility, real estate players, international actors, residential communities, individual entrepreneurs and households employ diverse typologies of socio-technical arrangements in meeting their daily water needs. As a result, the constant co-existence of the heterogeneous water supply configurations defy simplistic notions of transporting the modern infrastructure ideal in different contexts by way of revealing multiple modernities through variegated water provisioning mechanisms.

While this co-existence and co-production have complex implications for infrastructure and urban governance in general, the study urges policy makers, international actors, development partners and state agencies to shift focus to the existing multiple realities confronting them as opposed to burying their heads in borrowed monolithic ideologies that perpetuate urban inequalities. Particularly, the study suggests a deeper interrogation of the interface between the official planning models and their rationalities; and the growing grassroots initiatives in water provision fronted by different actors, agencies, institutions and communities. This interface promises a new perspective of understanding what socio-technical arrangements are suited for equitable provision and distribution of scarce water resources among the different socio-economic groups that compose the urban population.

ZUSAMMENFASSUNG

Die Wasserversorgung zählt zu den Infrastrukturen, die für das städtische Leben grundlegend sind. Aus diesem Grund wird seit langer Zeit von den Akteuren in Planung und Politik die Wasserversorgung für die Bevölkerung durch ein standardisiertes Infrastruktursystem angestrebt, das den "modernen" und "progressiven" Idealen entspricht. Die "vernetzte Stadt" ist ein solches Ideal, eine technologische Ideologie der westlichen Welt, die seit dem 19. Jahrhundert eine Grundlage für die Planung und Entwicklung der Wasserinfrastruktur auf der ganzen Welt ist. Dieses "moderne" Planungsmodell setzt eine zentral verwaltete und einheitliche Stadtstruktur als Bedingung für die Bereitstellung von vernetzten Infrastrukturen zur Versorgung mit Wasser, Elektrizität und Telekommunikation, sowie zur Entsorgung von Abwasser, voraus. Die Ideologie der vernetzten Stadt zeigt jedoch nur begrenzt Perspektiven auf für die vielfältigen sozio-technischen Arrangements der Wasserversorgung in vielen zeitgenössischen Städten. Dies trifft insbesondere auf postkoloniale Städte des Globalen Südens zu, die in rasantem Wandel begriffen sind. Die Sichtbarkeit von Wassertankern, Wasserkarren, langen Schlangen an Wasserkiosken, offengelegten Wasserrohren und allgegenwärtigen 20-Liter-Wasserkanistern im städtischen Raum offenbart die alltäglichen Improvisationen und die ungleichen Anstrengungen, die die Menschen in Städten des Globalen Südens auf sich nehmen, um ihre Versorgung mit Wasser sicherzustellen. Das Zusammenspiel der unterschiedlichen Formen der Wasserversorgung zum Erhalt städtischen Lebens verweist nachdrücklich auf das Konzept der multiplen Modernitäten, welches die westliche Vereinfachung im Sinne des "modernen" Ideals zentralisierter und vernetzter Infrastruktursysteme grundsätzlich in Frage stellt.

Diese Dissertation analysiert in einem sozio-technischen Ansatz bestehender Formen der Wasserversorgung in Städten des Globalen Südens an. Mittels einer interpretativen Fallstudie von Nairobi, Kenia, beleuchtet die vorliegende Arbeit in unterschiedlichen sozialräumlichen Typologien die Zusammenhänge zwischen der netzgebundenen Wasserinfrastruktur des öffentlichen Versorgungs-unternehmens einerseits und den vielfältigen nicht-netzgebundenen Wasserinfrastrukturmodellen, wie etwa privatisierten Infrastrukturenklaven, Praktiken des Wasserverkaufs, privaten Brunnen und Regenwassernutzung, andererseits. Die Studie verknüpft dabei Prozesse rasanten sozialräumlichen Wandels, wie die Herausbildung von städtischen Enklaven und informellen Siedlungen, sowie peri-urbane Zersiedelung, mit einer Betrachtung der politischen Ökonomie als prägendem Faktor für die Versorgung mit Wasserinfrastrukturen. Lokalisierte sozialräumliche Prozesse, die durch zirkulierende Planungsmodelle

geprägt werden und diese gleichzeitig prägen, und so ungleiche Geographien der Wasserversorgung Nairobis reproduzieren, sind das übergreifende Thema dieser Arbeit. Dies wird durch umfangreiche empirische Untersuchungen in vier verschiedenen Nachbarschaften belegt, nämlich Eastleigh (ein sich rasant wandelnder innerstädtischer Wohn- und Geschäftsbezirk), Runda (eine wohlhabende *Gated Community* am Stadtrand), Kayole Soweto (eine sich rasant wandelnde informelle Siedlung) und Ruai (ein peri-urbaner Bezirk). Jede der Fallstudien kennzeichnen unterschiedlichste sozioökonomische und politische Realitäten, die alle der Vision der Stadtbehörden widersprechen, ein integriertes "modernes" einheitliches Infrastruktursystem zu installieren. Insgesamt verdeutlichen die vier empirischen Fälle die Notwendigkeit, von der Ko-existenz, Ko-produktion und Ko-Governance heterogener Infrastrukturkonfigurationen auszugehen, um die Unzulänglichkeiten zentralisierter Infrastruktursysteme in rasant wachsenden Städten des 21. Jahrhunderts zu überkommen.

Wie die vorliegende Dissertation am Beispiel von Nairobi zeigt, sind diese Zusammenhänge und die Vielfalt der Infrastrukturen stark kontextbezogen zu interpretieren. Dieser Kontext ist, wie in vielen Städten des Globalen Südens, durch das Fehlen zentralisierter Dienstleistungen, eine sporadische und lückenhafte Versorgung oder vielfältige, nebeneinander existierende Modalitäten der Wasserversorgung gekennzeichnet. Diese Arbeit zeigt, dass es kein isoliertes Infrastrukturmodell gibt, sondern dass bestimmte Formen der Versorgung immer mit anderen Konfigurationen interagieren. Diese Interaktion kann der Funktionalität sowohl zuträglich als auch hinderlich sein. Es wird weiterhin deutlich, dass städtische Akteure der öffentlichen Verwaltung und des Immobiliensektors, Angehörige internationaler Organisationen, Wohnungsbaugesellschaften, Kleinunternehmer und Haushalte sich vielfältiger sozio-technischer Arrangements zur Deckung ihres täglichen Wasserbedarfs bedienen. Die ständige Koexistenz der heterogenen Wasserversorgungssysteme widersetzt sich daher der einfachen Vorstellung, die moderne Infrastruktur in unterschiedlichen sozialräumliche Zusammenhänge transportieren zu können, indem sie in den vielfältigen Mechanismen der Wasserbereitstellung multiple Modernitäten aufdecken.

Diese Koexistenz und Koproduktion haben im Allgemeinen komplexe Auswirkungen auf die städtische Infrastruktur und städtische Governance. Diese Dissertation fordert politische Entscheidungsträger, internationale Akteure, Entwicklungspartner und staatliche Stellen auf, ihren Fokus auf die vielschichtigen Realitäten zu erweitern, mit denen sie alltäglich konfrontiert sind, weiterhin auf externen und starren Ideologien zu beharren. Diese Ideologien festigen städtische Segregation und Fragmentierung nämlich

anstatt sie zu verringern. Die Arbeit erdeutlicht insbesondere den Bedarf einer tiefergehenden Auseinandersetzung mit der Schnittstelle zwischen offiziellen Planungsmodellen und ihren Rationalitäten einerseits, und den zunehmend aktiven bürgerschaftlichen Initiativen in der Wasserversorgung von verschiedenen Akteuren, Agenturen, Institutionen und Gemeinden andererseits. Die Betrachtung dieser Schnittstelle verspricht ein besseres Verständnis davon, welche sozio-technischen Arrangements für eine gerechte Bereitstellung und Verteilung der knappen Wasserressourcen unter den verschiedenen sozioökonomischen Gruppen der städtischen Bevölkerung geeignet sind.

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LIST OF ABBREVIATIONS

ADB	African Development Bank
AWSB	Athi Water Services Board
CBD	Central Business District
CBO	Community Based Organization
CGN	County Government of Nairobi
CO-HICs	CO-Heterogeneous Infrastructure Configurations
EBDA	Eastleigh Business District Association
ECRA	Eastleigh Community Residents Association
EDCC	Eastleigh District Commercial Center
GOK	Government of Kenya
KENSUP	Kenya Settlement Upgrading Programme
KISIP	Kenya Informal Settlement Improvement Project
LPDP	Local Physical Development Plan
MWI	Ministry of Water and Irrigation
NACOSTI	National Commission for Science, Technology and Innovation
NCWSC	Nairobi City Water and Sewerage Company
NCC	Nairobi City Council
NGO	Non-Governmental Organization
NIUDP	Nairobi Integrated Urban Development Plan
SAPs	Structural Adjustment Programmes
WARMA	Water Resources Management Authority
WASREB	Water Services Regulatory Board
WSD	Water Services Department
RRA	Runda Residents Association
RWL	Runda Water Limited.

1. INTRODUCTION

1.1 Overview

Infrastructure plays a critical role in the provision of basic services such as water and sanitation to urban residents. Besides service provision, the relationship between infrastructure and the urban space has been very integral in shaping and structuring development of cities for centuries (Kaika 2005; Dupuy 2008; Melosi 2008). Water, in particular, has played a central role in materializing visions of 'modernity' since the nineteenth century industrial growth (Kaika 2005; 2006). The urbanization of water became critical not only in solving the public health nuisances of the industrial cities, but also as a symbol expression of national progress in technology and modernization (Kaika and Swyngedouw 2000). Water infrastructure projects consisting of dams, reservoirs, together with underground pipes and networks became material symbols of national pride across the Western World during their invention (Ibid). For instance, the elimination of the 'great stink' from the heart of London, the imperial capital, through the construction of London sewers and embankment of the Thames, became a national project of the first order (Kaika 2006). In Paris, water and sanitation infrastructure works became one of Haussmann's main achievements in sanitizing and modernizing the rapidly expanding city (Gandy 1999). As such, water infrastructures became crucial political projects in producing 'hygienic' cities (Gandy 2004).

To date, urban infrastructures remain central in supporting urban functions such as movement of goods and services across space, communication, lighting, supply of domestic and industrial water, and waste disposal. Nevertheless, the role of infrastructures has been rendered subterranean and invisible from the ordinary landscape of the modern city, especially as advancement in engineering technology continues to confine them beneath cities (Kaika and Swyngedouw 2000). The hidden visibilities of urban infrastructures across contemporary cities is often taken for granted, sometimes assumed, or even naturalized and normalized in every day urban life (Graham 2010). For example, water has been systematically turned into an apparent triviality that miraculously enters the domestic sphere through the mouth of a tap (Kaika and Swyngedouw 2000). The water invisibility, on the other hand, encompass underlying and untold accounts of how it flows across different parts of the city. The untold stories begin from the source, storage, quality, quantity, distribution, access as well as material conduits, leakage, bursting pipes and the institutional and governance structures that control the use of water resources. It is such untold struggles of the flow of water that this

Dissertation unmasks through a detailed examination of the production of heterogeneous water supply configurations in Nairobi, Kenya.

The complexities of modern networked water infrastructures are revealed in unpredictable ways and moments (Kaika and Swyngedouw 2000). While infrastructures in developed Western societies only become visible during breakdowns and failure to deliver services (Graham 2010), infrastructure disruptions are always on the foreground across cities in the Global South (Silver 2013). The pronounced visibility of water trucks, hand cart pullers, long queues at water vending kiosks, exposed water pipes and the ubiquitous 20-litre jerry cans dotting the urban street depict, rather vividly, the everyday unequal struggles to improvise reliable water supply across different cities of the Global South. The reliance on interactions of numerous modes of water supply to sustain urban life is a clear indication of multiple modernities that defy simplistic Western universalization around the 'modern' ideal of centralized and networked infrastructure systems (Gandy 2006b; Dupuy 2008; Melosi 2008). In place of a homogeneous and universal 'networked city', I employ a heterogeneous infrastructure configurations lens in understanding the water landscapes in cities of the South, such as Nairobi. This study therefore provides a holistic socio-technical interpretation of infrastructure configurations particularly in post-colonial cities of the South as exemplified by multiple interactions of water supply models across variegated socio-spatial landscapes in Nairobi.

The remainder of this Introduction is structured as follow. First, I explain the main underlying assumptions of the networked city as well as its historical development in Section Two. This is then followed by a systematic socio-technical and contemporary post-colonial critique of the model in Section Three. The research objective and methodological framework is then elaborated in sections Four and Five, respectively. Section Six then closes the Introduction by outlining the overall structure of the Dissertation.

1.2 The 'modern infrastructure ideal' and the 'networked city' model

The 'modern infrastructural ideal' (Graham and Marvin 2001) is a technological ideology first advanced in discourses by urban engineers in the West in the Nineteenth Century, and which discourses continue to shape contemporary debates in and development of urban infrastructure across the world (ibid.). This 'modern' ideal presupposes a spatially and socially ubiquitous, top-down governed infrastructure system that provides exclusive and homogenous services across the city (Coutard and Rutherford 2016; Egyedi and Mehos 2012). The model presupposes a monolithic large-scale system of infrastructures (e.g. water,

sanitation, electricity and telecommunication) provided by the state or private monopolistic firms (Coutard and Rutherford 2016).

The technical networks for supply of urban services are 'black-boxed' and hidden in 'underground cities' (Graham 2010) with assumption that they are 'utterly fixed hard technologies characterized by perfect order, completeness, immanence and internal homogeneity' (Graham and Thrift 2007: 10). Further, the ideal frames infrastructures as 'public goods' whose construction, use, maintenance and extension is closely connected with land use regulation by the state (Graham and Marvin 2001). In this arrangement, service users are assumed to be passive consumers not capable of providing themselves with essential infrastructures and who must therefore rely solely on the utility provider for the satisfaction of their needs (Monstadt and Schramm 2017).

Fundamentally, the model envisions a universal 'networked city', which is a uniform urban configuration for the provision of networked infrastructures (Coutard and Rutherford 2016). Networked infrastructures refer to physical components consisting of immobile technical artifacts such as water pipes, sewers and electricity networks that shape the practical orientations and interactions of users of a technology, as well as corporate and regulatory structures that underpin such use (Monstadt 2009). Broadly, the achievement of the networked city requires a highly integrated socio-spatial context in terms of wider socioeconomic, institutional and political conditions, alongside increasing and redistributive revenues and income, poverty eradication and controlled urbanization (Coutard and Rutherford 2016). However, these conditions are hard to come by as contemporary cities are continuously faced by disintegration of economic and spatial conditions (Graham and Marvin 2001), rising informalities and unequal redistribution of resources that disenfranchise large sections of the urban population (Watson 2014). These contemporary socio-political dynamics pose serious challenges to the achievement of a universal networked city, particularly in weaker states and rapidly transforming cities of the Global South.

Notably, the networked city has remained politically and ideologically powerful in orienting infrastructure development plans in parts of the world where the ideal has not fully materialized (Coutard and Rutherford 2016). The ideal is especially promoted in contemporary urban and infrastructure planning by international investors and funding agencies, national and local policy makers, politicians, utility companies and academic experts (Monstadt and Schramm 2017; Coutard and Rutherford 2016). Yet, contemporary infrastructure

development patterns exhibit visible weaknesses of the networked city not just in poor cities of the Global South but also across capitalist cities of the Global North (Graham and Marvin 2001; Coutard and Rutherford 2016). The question begs, how did the networked city evolve through time and space to become a conventional blueprint for infrastructure planning and development?

1.2.1 Networked urban infrastructures: tracing the origins

The Nineteenth Century industrialization marked an important era for the introduction of centralized systems of water delivery in European and North American cities, as well as in their colonies (Gandy 2004; 2006b; Melosi 2008; Abbot 2012). For example, while Paris installed its water system in 1802, London's hydraulic work was done in 1808, as Berlin developed its water works later on in 1856 (Gandy 2006b). American cities on the other hand established networked blueprints for water supply among other environmental services such as sewers, drainage and solid waste disposal between 1830 and 1880 (Melosi 2008).

The move towards the construction of centralized and networked water systems across the industrial cities is largely attributed to historical accounts of environmental and public health discourses (Gandy 2006b; Melosi 2008). Incidences of cholera and yellow fever were fast spreading across the then rapidly industrializing cities of North America and Europe (Melosi 2008). This triggered intense discussions between the physicians, public health officers, sanitarians and urban administrators in an attempt to combat disease outbreaks of the time. Conclusions led to miasma ideologies and filth theories that were linked to the spread of diseases (Gandy 2004; Melosi 2008). The miasmatic theory transformed the notion of disease from having individual effects to wider societal, social and political reforms (Abbot 2012; Gandy 2006b). The implication of this far-reaching interpretation of epidemics provided the scientific rationale for development of centrally governed technologies of water services to replace individual family technologies such as wells and cesspits, which were at the time linked to the spread diseases (Abbot 2012; Melosi 2008).

By the middle Nineteenth Century, the 'bacteriological' theory discounted the prevailing miasmic ideologies in construction of technological networks and changing urban life (Gandy 2004). Following advancement in epidemiology and in the context of fast growing cities, newer technologies of water supply were implemented to replace the inefficiencies of older arrangements (Gandy 2004; Melosi 2008). Earlier sanitary arrangements of privies, cesspits, limited storm water, sewers and night soil collectors were overwhelmed by the 'water revolution' at the time (Gandy 2004). A new supply system was thus constructed to deliver pure and abundant

water not only for human consumption, but also for the removal of sewage from homes and businesses, fire protection and industrial use (Melosi 2008; Gandy 2006a). This was aimed at combating spread of diseases but more importantly, it transformed the design, use and meaning of private space and thereby greatly reshaped urban space (Gandy 2006b). There was growing water use within individual homes due to emergence of water closets and bathrooms that slowly replaced public baths and changed patterns of everyday life (Kaika and Swyngedouw 2000). The relationship between water and the human body was transformed through a new hydrological order suited for the modern city (Gandy 2006b). In America for instance, the construction of first water works in Philadelphia in 1796 provided new levels of user convenience and enabled large-scale expansion of industry (Melosi 2008). Meanwhile, the increased water demand led to growing numbers of water works across America from 45 in 1830 to 599 in 1880 and 9,850 by 1924 (Melosi 2008: 51, 82).

In essence, the bacteriological city was defined by 'new moral geographies and modes of social discipline based upon ideologies of cleanliness; a move away from laissez-faire policies towards a technocratic and rational model of municipal managerialism, and a connection between urban infrastructures and citizenship rights' (Gandy 2004: 363). It became a new socio-spatial arrangement for ensuring social cohesion while protecting the political and economic functions of the modern city (ibid.). Gabriel Dupuy for instance describes how the development of infrastructure networks influenced the construction and management of urban areas within Haussmann's Nineteenth Century 'modernization' of Paris. According to Dupuy (2008), Haussmann's administration designed the first technical systems to supply urban populations with basic services consisting of running water, sanitation, power and transport. Haussmann pushed for the linking of fragmented parts of Paris through networks of drains and fresh water supply by conceiving a hierarchical network from the aqueducts to the local water mains in a dwelling. The networks' regulation was limited to the administrative city boundary marked by fortifications, whereby the top and the center dominated the base and periphery, respectively. Extension of networks beyond the traditional urban borders was nevertheless realized only later across French cities such as Nantes (Dupuy 2008).

The bacteriological city became a logical ideal to the scientific and spatial rationalization underway since the beginning of the Nineteenth Century industrial period (Gandy 2004). The hydraulic networks consisting of large dams, new reservoirs, pumping houses and water towers that accompanied the bacteriological city became iconic embodiments of engineering progress and modernity. Kaika and Swyngedouw (2000) discuss

in-depth how the technology of networks, together with their iconic structures, were celebrated in a fetishized phantasmagoria as material expressions of progress, continuity and triumphant future. The everyday lived experience that came with water and sewer networks and connections encapsulated technological progress into the urban domain (ibid.). The urban networks represented stable constellation of engineering structures (e.g water towers and dams) that would sustain filtered and clean delivery of water to the growing cities. More importantly, it set the motion for an integrated technological networks of water, sewer, electricity and gas with assumption that all cities would replicate this model in what is termed as the 'modern infrastructural ideal' (Graham and Marvin 2001).

Upon completion of the engineering works, the infrastructural networks were buried in subterranean urban underworld, rendering them invisible on the urban surface (Kaika and Swyngedouw 2000). The connection cables, pipes, dams and reservoirs are no longer located in the city's skyline, subjecting their production process also in the background (ibid.). Although normalized to urban invisibility in underground cities (Graham 2010), the revamped twenty-first century networked infrastructure model still carries the images, representations and ideologies of progress and modernity (Kaika and Swyngedouw 2000). Notably, the 'network urbanism' (Dupuy 2008) has continued to give rise to the production of different and relatively stable urban forms. For instance, there is reference to 'electropolis' for collective energy and power generation (Graham and Marvin 2001); 'hydropolis' (Gandy and Frank 2006), 'sanitary city' (Melosi 2008) or 'bacteriological city' (Gandy 2006b) for water and waste systems; 'cybercity' for information and communication infrastructure configurations, and 'autocity' for motorized and related technologies (Graham and Marvin 2001). Since then, networks have continued to shape urban development and being shaped in return by urban conditions (Graham and Marvin 2001; Dupuy 2008).

More important to note, the co-evolution of the modern infrastructural ideal revolved around the interaction between technology on the one hand; and financing, political and institutional formation, on the other hand (Gandy 2004; Abbot 2012). The technical systems of networks represented public goods, hence municipalization so as to achieve a unified, centralized and quality standards of water services (Gandy 2006b). Centralization, it was argued, would increase efficiency and control by offering permanent solutions to service delivery, disease eradication and stimulation of city growth (Melosi 2008). This implied a move from private and labour-intensive water supply mechanisms to capital-intensive engineering infrastructure projects (ibid.). Due to increasing public expenditure, creative financial instruments such as municipal bonds

were largely deployed to finance completion of some of the ambitious engineering projects (Melosi 2008; Gandy 2006b).

In addition, new policy instruments such as the power of eminent domain to override private interests, and acquisition of private lands for infrastructure construction and protection of water systems from possible contamination informed the replacement of private water providers with public ownership (Gandy 2006b). Furthermore, new technical and managerial expertise in urban governance restructured municipalities with engineers, public health officers and an industrial bourgeoisie having strong voices over urban affairs (Gandy 2004). More tellingly, the rise of the network ideology presupposed that network performance would keep pace with city growth in terms of spatial coverage, number and diversity of users, besides providing solutions within themselves (Coutard and Rutherford 2016). The 'network' therefore became a conventional model for all cities to emulate.

1.3 Infrastructure as socio-technical systems: a critique of the networked city

It is clear that urban infrastructures have undergone a full cycle of evolution to become what we know as the networked city. The transition from disjointed and multiple service provisions of the Nineteenth Century to a fully networked city was however a gradual and sometimes an incomplete project requiring other technologies to fill in the gaps left by the centralized system. What we experience presently is a return to fragmentation and decentralized systems of urban infrastructures as more questions are raised about the efficacy, vulnerability, neoliberalization and sustainability of centralized, large technical systems. Despite the centralization and modernization of urban services into networked infrastructures, this has never meant a complete wipe out of other means and modes of service provision. At the same time, exclusionary mechanisms were always embedded in the expansion of the networks, leaving some parts of urban areas unconnected to services either due to racial, class, economic, or political reasons, or just due to sheer neglect. These excluded areas still relied on decentralized and smaller technologies of water supply such as wells, collection of surface water and water vendors. Nevertheless, this co-existence and co-provisioning of urban services has remained marginal in the construction of the networked city narrative. It is therefore key objective of this study to illuminate the multiple technological modernities that structure contemporary urban water supply.

Rather than viewing infrastructures as technical artifacts solely under the domain of engineers, a socio-technical approach that embraces the politics and social relations embedded in the (re)production, translation, transformation and everyday use of infrastructure is gradually gaining ground among contemporary urban researchers (Coutard and Rutherford 2016; McFarlane 2010; McFarlane and Rutherford 2008; Gandy 2004; 2006b; Graham 2010; Graham and Marvin 2001). Such a socio-technical perspective on infrastructure combines political, economic, social and environmental dimensions in reading the configuration of contemporary urban infrastructure services. Essentially, a socio-technical approach considers the interactions between technical artifacts, institutions and organizations on one hand, and their interactions with political, economic and demographic processes on the other (Nilsson and Nyanchaga 2008).

Burying the flow of water in underground networks does not obliterate the social relations through which metabolic urbanization of water takes place (Kaika 2005). The flow of water is entangled with intricate relationship between use value, exchange value and social power (Kaika and Swyngedouw 2000). In clearer terms, the implementation of networked systems of infrastructure and water delivery was not realized in a uniform social democratic fashion across the industrial towns (Gandy 2006b; Melosi 2008). In fact, Kaika and Swyngedouw (2000: 131) have observed,

> Marveling at networks, dams or water towers as embodiments of urban emancipation obscured seeing the exploitation of living labour and the socioecological transformation involved in the process of their production. Stripping those objects of their social meaning left them as mere fetishes and idols, phantom-like material expressions of a myth of progress and an ideology of automatic emancipation.

Indeed, the fetish role of networks hid underlying social power relations, whereby connection to urban networks carried with it exclusion and segregation practices (Kaika and Swyngedouw 2000; Gandy 2006b). For example, the Haussmann administration opposed the discharge of human wastes into new sewers of Second Empire Paris, which was first a preserve for the bourgeois (Gandy 1999). Elsewhere, the introduction of bathrooms and water closets was restricted to the middle-class households before wider diffusion took off (Kaika and Swyngedouw 2000). These inequalities imply that urban infrastructure systems are not neutral objects and their production and reproduction involves a political process that interplay with multiple values, models, representations and practices of various stakeholders to (re)shape power relations (Gandy 2004;

Coutard and Rutherford 2016). Nevertheless, the conflicted political and economic dynamics amid capitalistic urbanization did not deter achievement of modernization of urban services in the West by early twentieth century, setting the conventional standards upon which infrastructure systems have continued to be developed around the Globe. Through a socio-technical lens, this study captures lost narratives in reconstructing and redefining infrastructure configurations particularly in cities of the Global South. I seek a broader reading of infrastructure that encompasses urban governance issues surrounding the provision of water, institutional and regulatory frameworks for spatial and water practices, contextual urban development processes and the role played by the state, private actors, civil society groups and grassroots community institutions in the day-to-day supply of water in Nairobi. My position is that the networked city is limited in grasping the structural and critical nuances that surrounds development and access to urban infrastructures and their services. The networked city thus presents key conceptual and empirical problematics calling for new construction of holistic nuances and grounded narrative explaining how infrastructures are configured by different power relations at various levels and scales of urban areas. It is such hidden politics and underlying limitations of the networked city that I strive to unfold throughout this study.

1.3.1 State of the art: contemporary debates on socio-technical infrastructures

While infrastructures of the Nineteenth Century were seen in functional terms, structural dimensions to urban change have tended to dominate contemporary debates. For instance, Gandy (2004) argues that infrastructure systems are better understood in more relational and hybridized dynamics rather than as functional-linear notions of urban metabolic systems. Unlike the previous attention paid to networked infrastructure as the technical and material underpinning for modern urbanization (Dodson 2009), latest research points to inadequacies and limitations of this universal model in different local contexts (Coutard and Rutherford 2016; Gandy 2004; 2006b; McFarlane 2008).

The volume *Splintering Urbanism* (Graham and Marvin 2001) is one of the key literature that pushed the 'hidden city' of networked infrastructures to the fore of contemporary investigation. Although attracting sharp criticisms for lack of historical and empirical depth (Coutard 2008), the splintering thesis instigated invigorating research on this topic. Ensuing literature continues to demonstrate variations of 'splintering' effects beyond changes in political economy caused by neoliberalization, while discounting the existence of a universal network as a starting point. For instance, Kooy and Bakker (2008) argue that infrastructures in post-colonial cities were 'splintered' from the onset of their development during the colonial period (see also

McFarlane 2008; McFarlane and Rutherford 2008). Development of urban services such as piped water favored the colonial masters and political elites, at the expense of the rest of the urban population, resulting in dualistic infrastructure systems (Zérah 2008).

Elsewhere, Bakker (2003) uses the term 'archipelagos' in place of the metaphor of 'networks' to capture the complex overlapping water supply strategies that prevail in cities of the Global South. Meanwhile, Graham (2000) points to an emerging urban trend of construction of 'premium networked spaces' that further disintegrate or splinter the networked ideal into pockets of specialized and customized infrastructure sub-systems for the high-end consumers. All in all, these authors are in agreement that deployment of the modern infrastructural ideal across different urban environments has impacts of fragmentation, socio-spatial inequalities, alienation and enhanced social exclusion, particularly of the urban poor (Graham and Marvin 2001; Gandy 2004; 2006b; Coutard and Rutherford 2016; McFarlane and Rutherford 2008).

Recently, some researchers have started to question the efficiency and reliability of networked infrastructures based on recent experiences of network failures and vulnerabilities in everyday urban life (Hommels et al. 2014; Högselius et al. 2013; Graham 2010; Shove et al. 2009). Högselius et al. (2013) for instance raise awareness on the paradox of simultaneous vulnerability and reliability of highly connected infrastructures, whose system and user vulnerability magnitude surges with higher dependence on steady infrastructure services across modern societies. Consequently, the interdependence of technological systems and life-styles put the contemporary society at greater risks of disruption than ever before. Not only that, this has escalated to a point whereby disruption is today normalized in everyday life (Trentmann 2010). Högselius et al. (2013) therefore suggest a reflective historical re-examination of infrastructures to better understand this paradox as 'yesterday's solutions can cause today's problems' (p, 6).

On the other hand, Hommels et al. (2014) view vulnerability as a learning and adaptation process that may create more flexible and resilient societies based on creative coping mechanisms. This raises the question of whether cities in the Global South are more adapted and resilient, since they are constantly improvising back-up services of say water and energy for their daily survival, beyond the mainstream infrastructure systems (Graham and Thrift 2007; McFarlane 2010). A comprehensive focus on the politics of infrastructure failure is offered by Stephen Graham's edited volume on *Disrupted Cities* (Graham 2010). In this collection, various authors excavate and problematize the very normalities of flow and circulation of services by exposing

the hidden politics of urban life during infrastructure failures. The book argues that infrastructures become more visible when flow of services such as water, electricity and wastes are disrupted by system malfunction or failure (see also McFarlane and Rutherford 2008). By focusing on moments of failures, the collection reveals the power and value-laden nature of urban infrastructure systems, beyond the supposedly technocratic engineer's purview (Silver 2016; Graham 2010, McFarlane 2010).

On their part, Graham and Thrift (2007) remind us of the neglected field of repair and maintenance that actually keeps our modern societies going. In their view, the 'myth of infrastructure as fixed and stable emplacement' should be reconsidered through the lens of infrastructure as 'leaky, partial and heterogeneous' artifacts (Graham and Thrift 2007: 10). The authors assert that the black-boxing of standardized, normalized and immanent urban infrastructures deflect attention from repair and maintenance, which only become visible after catastrophic events. Yet repair and maintenance can be a source of variation, improvisation and innovation (ibid.).

1.3.2 Towards a post-colonial critique of the networked city

The influence of the North cannot be overstated in shaping urban planning practices and infrastructure models across the Global South (Abbot 2012; Myers 2011; Watson 2009a). This is also reflected in the scholarly literature production, whereby recent resurgence of the 'infrastructure turn' triggered by Graham and Marvins's splintering thesis have seen cities of the North dominating in the urban discourses (Graham and Thrift 2007). Yet, much of this literature points to the lack of homogeneity and universality of the supposedly integrated infrastructure ideal; not only in the Global South, but also in cities of the West (Graham and Marvin 2001; McFarlane and Rutherford 2008; Coutard 2008; Gandy 2006b). Despite the pre-dominance of the 'infrastructure turn' in urban research, little attention has been paid to the socio-technical configuration of urban services in the Global South contexts (Monstadt and Schramm 2016; 2017). Robinson (2006) alludes to a general disregard of engaging with the Global South urbanism within dominant discourses of urban studies.

Notably, the presuppositions of a networked city present rather limited and narrow theoretical strands that can ill afford deeper understanding of the complexities of infrastructure configurations in cities of the South (Furlong 2014). Infrastructure systems in the Southern context is mainly described as 'hybridized socio-technical assemblages that emerge at the margins of, interstices of, in combination with, or simply in place

of existing (or indeed absent) centralized infrastructure networks' (Coutard and Rutherford 2016: 9). Moreover, infrastructures in the South continue to be viewed in terms of breakdowns or ongoing disruptions and failures, and/or lacking networked services altogether (Monstadt and Schramm 2017; Silver 2016; Mcfarlane 2010). Until recently, the infrastructure problem was perceived as a temporary phenomenon that would easily be overcome through vigorous urban planning and reconstruction (Gandy 2004). It is such assumptions embedded in the networked ideal that have obscured constructive and deeper discussions, which can otherwise be achieved through rich historicized accounts and situated empirical analysis of socio-technical systems in cities of the South.

Lately, more and more focus is given to cities of the Global South, where underlying weaknesses of the universal networked ideal are extensively exhibited through hybrid forms of service provision and appropriation (Simone 2004; Monstadt and Schramm 2017). Depending on the geographical and historical context, the implementation of the networked infrastructure system has taken different forms, which are further intertwined with complex economic and political dynamics shaping urbanization trends and resource distribution. According to Gandy (2006a), the infrastructure crisis experienced in cities of the South is not a simple matter of technical and fiscal limitation required in the reproduction of the networked city. Rather, it is as a result of the legacy of an incomplete modernity that sharply distinguishes between 'citizens' and 'subjects' in the provision of urban services (McFarlane 2008). This lays a good foundation to better understand the colonial and post-colonial water regimes in Nairobi and the contextual intricacies created through the imposition of the networked ideal by the British imperialists and later on by the post-colonial Kenyan state (see Chapter two).

Through post-colonial approaches, a number of critical scholars have recently focused their analysis in some of the neglected cities of the South (Gandy 2008; McFarlane 2008; Kooy and Bakker 2008; Monstadt and Schramm 2013). Notably, few cities from sub-Saharan Africa feature in this literature (see Myers 2011) with only a few studies from the region (Silver 2016; Abbot 2012; Jaglin 2008; 2016; Gandy 2006a). This is despite the fact that the sub-Saharan region constitutes some of the 'megacities' shaping current urbanization trends globally (UN-Habitat 2014). Latest development in the East African region nonetheless shows new research interest in post-colonial studies of urban infrastructures there (Nilsson 2006; Monstadt and Schramm 2017; Monstadt et al. *forthcoming*). For example, Monstadt and Schramn (2017) employ a postcolonial critique and a science and technology approach to investigate the translation of the modern infrastructural ideal in Dar es

Salaam's water supply and sewer system. In the course of translation, the authors argue, different and alternative modernities are manifested through processes of adaptation, hybridization, appropriation or refusal of the circulating networked ideal (Monstadt and Schramm 2017). This finding is in line with previous studies, which have similarly concluded that the transplanting of the networked city defies simplistic notions of technology, ideological and practice transfer while being circulated from one context to another (Arnold 2005; Hård and Misa 2008).

However, these studies remain very limited in understanding the structural intricacies that surrounds hybridized urban infrastructure systems of cities from this region and the Global South at large. Therefore, more studies are needed to unravel the complexity of the co-existence and interplay of the actually existing systems of urban services on one hand, and their socio-economic implications across the different socio-spatial topologies that characterize cities on the other hand. It is this research gap that my dissertation seeks to fill.

1.4 Research objective(s) and significance

My conceptual point of departure is that water-provisioning mechanisms in Nairobi embody both conventional and non-conventional approaches, both of which co-exist in complementarity and contradictory ways in order to satisfy the existential needs of the city's bulging population. Through a comprehensive conceptual and socio-spatially situated empirical accounts of water supply in Nairobi, this Dissertation questions the continued use of the 'modern infrastructural ideal' by water utilities, urban planners, consultancies, international donors and financial institutions to singly plan, design, finance, regulate, supply and manage water infrastructure services.

The 'modern' ideal no doubt informed the British colonial policies of water provision in Nairobi, and has continued to shape infrastructure planning in the city up till now. However, this continues to unravel without taking into account the changing dynamics of urban development. The argument I put forward in this study is that the conventional model does not address the socio-spatial inequalities created as a result of what has been termed the African 'urban crisis' (Roy 2009; Watson 2009b). This crisis is shaped by rapid urbanization alongside uneven real estate development, expansion of informal settlements and rising income and wealth inequalities (Watson 2014). The networked ideal thus provides little insight into the current redesigning of infrastructures in the context of contemporary urban planning and development (Monstadt 2009).

Moreover, previous attempts to construct cross-cutting interdisciplinary perspectives of the changing dynamics between technology, infrastructure and urban space (Graham and Marvin 2001) have attracted methodological and theoretical critiques (Coutard 2008). As a response, more research is needed in building planning concepts grounded in the geographical, social, economic and technical realities of cities of the Global South (Watson 2009a; Roy 2011). This Dissertation is therefore a modest contribution to the raging debates on contemporary infrastructure and urban configurations especially of 'ordinary cities' (Robinson 2006) like Nairobi.

Empirically, I engage with varieties of socio-technical realities exhibited in different neighborhoods within the city of Nairobi. Rather than limiting the discussion to the confines of 'the modern infrastructural ideal', I argue for co-existence, co-production and heterogeneity of water (sub-)systems (Furlong 2014; Jaglin 2008; 2014; 2016; Allen et al. 2016; Lawhon et. al *forthcoming*) that well capture local nuances in Nairobi's water supply arrangements. I argue that rather than one monolithic entity, Nairobi's water supply is a combination of multiple models operating across variegated settlements, and which function in complementary ways, parallel, and in contrast to the networked system. The interrelations and multiplicity of infrastructure interpretations as I suggest for Nairobi, relate closely with contexts characterized by either no centralized service, intermittent supply and/or multiple modalities of water supply as is the situation in many cities of the Global South (Jaglin 2014).

The central research objective then is to understand the interrelations between the different infrastructure and service provisioning mechanisms in Nairobi's water supply system(s). To achieve this objective, I first analyze the co-evolution of the water regime(s) in Nairobi, from the colonial administration to the present (chapter two). Water regimes help to identify dominant patterns of infrastructure planning and designing, ideologies, institutions, rules and norms, actors, financiers and practices assembled for provision of water services, including their social, economic, political and spatial implications on different social groups. Secondly, I examine the interplay between the networked water infrastructure run by public utility companies on one hand, and the multiple non-networked water supply mechanisms such as privatized decentralized systems, water vendors and individual/communal boreholes across different socio-spatial topologies in Nairobi (chapters three to six). Finally, I interrogate the contradictions, contestations, complementarities and co-operation among the different water supply models in charting a more inclusive infrastructure lens (chapter seven).

Brought together, the research should be useful in charting out a different path for (1) holistic reading of the contemporary city; (2) understanding all-inclusive infrastructure configurations; and (3) improving the city's water supply infrastructure system(s). The overall aim is to rethink practical models of water supply within rapidly transforming cities of the Global South in the quest to counter inequalities and marginalization of especially the urban poor as perpetuated by the monophonic yet unattainable and elusive dream of a universal networked city model.

1.5 Research methodology

A research methodology is a strategy that translates ontological and epistemological principles into guidelines that show how research is conducted, together with the principles, procedures and practices that govern research (Sarantakos 2005). The selection of methodology depends on the research paradigm in terms of the nature of reality and humanity (ontology), theory of knowledge (epistemology) and how that knowledge is attained (methodology) (Tuli 2010). This Dissertation is the outcome of an interpretivist epistemology that believes in social construction of multiple, complex and changing realities, that is, constructionist ontology (Neuman 2003; Mutch 2005; Schwandt 1994; Hennink et al. 2011). In contrast to positivism that assumes one universal truth that governs social events and is able to describe, predict and control social phenomena, the interpretivist lens employed here seeks to understand different values, beliefs and meanings of social phenomena through deeper inquiry of human cultural activities and experiences (Tuli 2010). The theoretical framework I employ in this work sees the world as constructed, interpreted and experienced by people in their day-to-day interactions with each other and the wider societal systems (Maxwel 2006; Willis 2007). In this research therefore, I go beyond deductive and inductive approaches in trying to discover the social construction processes to uncover deeper understanding of the research problem in its unique context as opposed to being overly concerned with statistical generalizability (Ulin et al. 2004).

The philosophical underpinning of constructivist-interpretivist paradigm I employ here provides the foundation that anchors qualitative research methods. Proponents of interpretivism emphasize the importance of understanding lived experiences from the point of view of those who live it (Schwandt 2000). The lived experience occurs within a historical social reality. This historicized account is crucial in deconstructing the Western ideology of a networked city as the universal model in laying out urban infrastructures. The translation, transition, interpretation and experience of the model among different cultures brings out varying meanings and interpretations of urban infrastructures by those who experience its construction and use in

the provision of basic services or lack thereof. An interpretivist paradigm, I reckon, helps to broaden the research to be more inclusive by accepting multiple viewpoints of different actors from different socio-economic groups across varying socio-spatial arrangements within cities. The resultant multiple perspectives in the end lead to a more comprehensive understanding of the situation under investigation, coming as it does from in-depth and insightful information from various living populations rather than statistical numbers (Willis 2007; Klein and Meyers 1998; Morehouse 2011). It is for this reason that I settled for a case study approach to suitably inform my research design in gathering interpretive information.

1.5.1 Research design

This research employs the case study method. A case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between the phenomenon and context are not clearly evident (Yin 2009). Case studies allow in-depth research, especially where a nuanced understanding of a critical urban issue, such as that of production of unequal water infrastructure patterns in Nairobi, is needed. As the production of different urban water supply patterns is closely intertwined with local urban development dynamics, it implies that the research is embedded within the local and wider social, economic and political contexts that structure overall urban development in Nairobi. More importantly, a case study approach aims at linking the empirical evidence with research questions in order to advance theoretical development. The Dissertation sought to problematize the applicability of dominant planning models for infrastructure provision with respect to Southern cities such as Nairobi. The aim has not been to generalize the results of Nairobi to the wider pool of 'global South cities'. Rather, my aim has been to learn from the case of Nairobi by criticizing the networked infrastructure model while providing an alternative reading of cities and infrastructures through the lens of heterogeneity, co-production and co-existence, as opposed to homogeneity and universality purported by the idealized networked city model.

In order to understand the heterogeneity of the socio-spatial arrangements of water supply within Nairobi, I went further to employ a multiple case design to enrich both the conceptual and empirical framework. It is important to note that the use of multiple cases in this work was not intended to offer a comparative perspective across the city's water infrastructure supply landscape. Rather, each of the cases presented herein is unique on its own right and offers inimitable contribution that cumulatively add up to answer the research question(s). The research draws critical empirical lessons from each of these cases as they clearly demonstrate different socio-spatial arrangements of water supply. More importantly, the multiple cases help

to critique the homogeneity and ambiguity of the networked infrastructure model and urban space production in general. Ultimately, the multiple cases help to expand the understanding of how variegated infrastructure configurations are co-produced and co-exist with each other within the city of Nairobi.

As Scapens (2004) suggests, in the case study design, cases should be sought carefully in which the social phenomena being observed there can result in rich and important contributions to the research question. The chosen case should be critical in testing or broadening a theory's application into a wider range of circumstances. In this case, purposive sampling has been employed where pre-determined reasons are known, with cases chosen based on their richness and matched criteria in answering the research questions (Bloor and Wood 2006). As Devers and Frankel (2000) explain, purposive sampling is a subjective way of selecting 'information rich' cases that provide the greatest insight into the research question. Consequently, I employed purposive sampling in choosing the four cases discussed here to reflect richly on different socio-spatial development patterns that characterize the water supply arrangements in the city of Nairobi. The cases chosen for this study are therefore not similar. Instead, they are heterogeneous samples (Holloway and Wheeler 1996; Robson 2002). The aim was to get a broad spectrum of ideas and diversity of urban settings that vary from each other, yet have one central theme that cuts across to answer the main research question. It is important to reiterate that the multiple cases presented here help in getting empirical material for analytical generalization rather than sampling for proportionality. In this regard, four cases were studied namely, Eastleigh, Kayole Soweto, Runda, and Ruai. But why these cases in particular? And why Nairobi, anyway?

1.5.2 Research justifications

There are several reasons for choosing Nairobi as the main empirical case in demonstrating the limitation of the universality of transferred Western planning models such as the 'modern infrastructural ideal'. First, Nairobi is a good example of a post-colonial city providing deep insights through its historical British foundation and contemporary postcolonial urban regimes as concerns planning and infrastructure development. The history across time and space embeds the discussion within broader political and economic structuring programs and city governance to shed light on how and why Nairobi's water supply is what it is today. The current socio-spatial differences within the city is therefore traced back to the colonial roots that not only influenced its spatial and infrastructure planning ideals, but left significant structural legacies of inequality, segregation and marginalization of weaker groups as experienced today.

Second, Nairobi is an exemplar city that is undergoing rapid demographic and spatial transformation. The unprecedented urbanization raises important scholarly interests particularly in understanding the political, social and economic processes shaping growing cities in Africa. My inquiry looks at water supply in close relation with these processes to better illuminate the diversity of urban development processes; how the needs of rising urban population are met (or not met) by current regimes; and how multiple interests, actors and resources are mobilized to fill in the gaps left by conventional state and market mechanisms in public service delivery.

Thirdly, recent debates on urban infrastructure has limitedly featured on sub Saharan African cities, yet there is a lot to learn from these cases. By studying Nairobi, the research seeks to contribute to 'provincializing' of mainstream knowledge (Sheppard et al. 2013; Lawhon et al. 2014) by bringing infrastructure issues within the city in direct conversation with dominant narratives of urban space production. More fundamentally, this provincializing helps in deconstructing conventional imaginaries of the city by speaking back, contesting, disrupting and elucidating new loci of knowledge in order to broaden the scope for theorizing with different urban experiences (Robinson 2006; 2008; Parnell and Robinson 2012; Sheppard et al. 2013; Lawhon et al. 2014).

Fourthly, the economic and political importance of Nairobi as the capital city of Kenya brings the city to the limelight, necessitating continuous and vigorous research to improve Nairobi's planning and infrastructure development, which taken together, are the backbone of economic growth. Finally, my knowledge of Nairobi, having lived and worked there as an urban planner for over ten years, informed the choice of Nairobi as a case worth utilizing in interrogating the networked infrastructure ideal.

Bearing all the foregoing in mind, I chose to study four cases within Nairobi to epitomize a mixture of socio-spatial water supply arrangements in terms of contextual local place-based histories of spatial and infrastructure development; localized governance systems; diversity of actors; and different socio-economic class, among other aspects of water practices. The four cases represent a blend of a colonial-planned settlement and fast transforming residential cum commercial inner city district (Eastleigh), an informal settlement (Kayole Soweto), a gated neighborhood (Runda), and a peri-urban settlement (Ruai), all within the administrative boundaries of Nairobi (figure 1-1).

To begin with, I chose to study water supply in Eastleigh since the neighbourhood represents a colonial old planned settlement that was once adequately serviced with a centralized water supply system until the recent urbanization craze overwhelmed the system owing to increased demand. The colonial administration oversaw the planning of Eastleigh and designated it as the Asian housing enclave. The neighbourhood's water infrastructure was laid out in every street to serve each dwelling unit with clean municipal water. Over time, Eastleigh has experienced rapid socio-spatial transformation in terms of demographic explosion and change of development densities. Previous single-dwelling units have been replaced with high-rise apartments and mini shopping malls. The original residential mono function no longer holds as the area has since been reclassified by the Nairobi County Government as an extended business district, allowing mega commercial developments to take root in the area. These changes, mostly propelled by the influx of ethnic Somali groups, who currently dominate businesses and residences in the area, have resulted into a dynamic complex mesh of infrastructure problems amid limited capacity of the city authorities to keep pace with transformations there. The case therefore aptly demonstrates how rapid socio-spatial transformations over time and space have shaped the functioning of the networked infrastructure in Eastleigh, and how in turn the planning authorities and utilities, residents and businesses have devised mechanisms of making do with reduced water pressure and intermittent supply regimes.

The choice of Kayole Soweto was informed by its very nature of being an informal settlement that has not received much research attention compared to similar settlements such as the infamous Kibera and Mathare, which mostly feature in the informality debates on Nairobi. Kayole Soweto therefore brings a fresh breath of dynamics involved in servicing informally developing areas by re-evaluating the official and grassroots trajectory in provision of water services. Unlike many informal settlements which sit on illegal land, Kayole Soweto's tenure status is quasi legal because the settlement was authorized through a presidential decree to facilitate rehousing of displaced persons from other parts of the city. However, the land registration process was not completed, leaving residents with allotment letters. The problem of allotment letters is that they are never legally recognized until one receives a land title deed confering absolute ownership on the parcel allotted. Following allotment process, the allottees in Kayole Soweto have built temporary housing structures giving the settlement a typical informal character. As a consequence, and compounded by the low socio-economic profile of the inhabitants, the area has remained marginalized by utilities and planning authorities. Fortunately, recent water sector reforms in accordance with the Kenyan constitution of 2010 have brought changes in the way inhabitants of Kayole Soweto obtain water. While these changes have meant extension

of centralized networks into the settlement, the utility company has had to collaborate closely with the community and other external partners in fine-tuning and reworking the centralized model to practically fit with the local community needs and capabilities. Local innovation in infrastructure financing, construction and management have thus greatly transformed local governance practices that greatly challenges the business-as-usual approach in conventional infrastructure development.

The case of Runda is distinct due to the very powerful nature of the economic and political class living there, as well as by the neighbourhood's status as a gated community. Runda was conceived by real estate investors in the early 1970s to cater for the housing need of increasing expatriates and diplomats working at the neighbouring United Nations Complex and foreign embassies in the adjacent areas of Gigiri. At the time, the Nairobi City administration lacked requisite capital to extend water services into the area noting that Runda was located in the suburbs, way off the centralized water network at the time. The private developers resolved to construct their own water treatment plant on the Ruaka River that flows across Runda. Runda Water Limited (RWL) was thus born as a private water provider, operating parallel to the state water utility. After several years of operation, the Runda Residents Association (RRA) bought off the water company from the initial developers and are to-date the owners of RWL. I chose this case specifically to expound on emergence of totally decentralized water systems, governed, owned, operated and managed by private residential associations and real estate developers. The case demonstrates emergence of enclave infrastructure systems alongside the rise of gated neighborhoods and upcoming satellite cities that instead seek their own customized infrastructure systems that by-pass wider city integration.

Lastly, I chose Ruai to explicate the problematic of peri-urban zones in the planning and development of water infrastructure systems. Ruai is situated on the Eastern edge of Nairobi and is classified as a low density residential zone with a mixture of agricultural activities. Notwithstanding, this peri-urban zone has transformed into a large commercial center following the construction of major transportation networks that have eased accessibility to the CBD. Today, Ruai also hosts the largest sewerage treatment plant and is likely to host the city's proposed new garbage dumping site, according to latest debates on the relocation of the current Dandora Dumpsite. As a result, the area has continued to act as the sink of the city's metabolic wastes, at the expense of ordinary inhabitants and their existential needs such as clean water supply. Connection to the central networks has not taken off in various sections of the settlement, with only wealthier households able to finance network expansion to their residences. This situation has left many Ruai residents to depend

on water bought from connected premises, while reliance on borehole water and water vendors is rampant across the settlement. I therefore chose this case to bring pertinent issues of peri-urban zones to the fore of current infrastructure debates that have in the past, tended to focus overly on inner city areas.

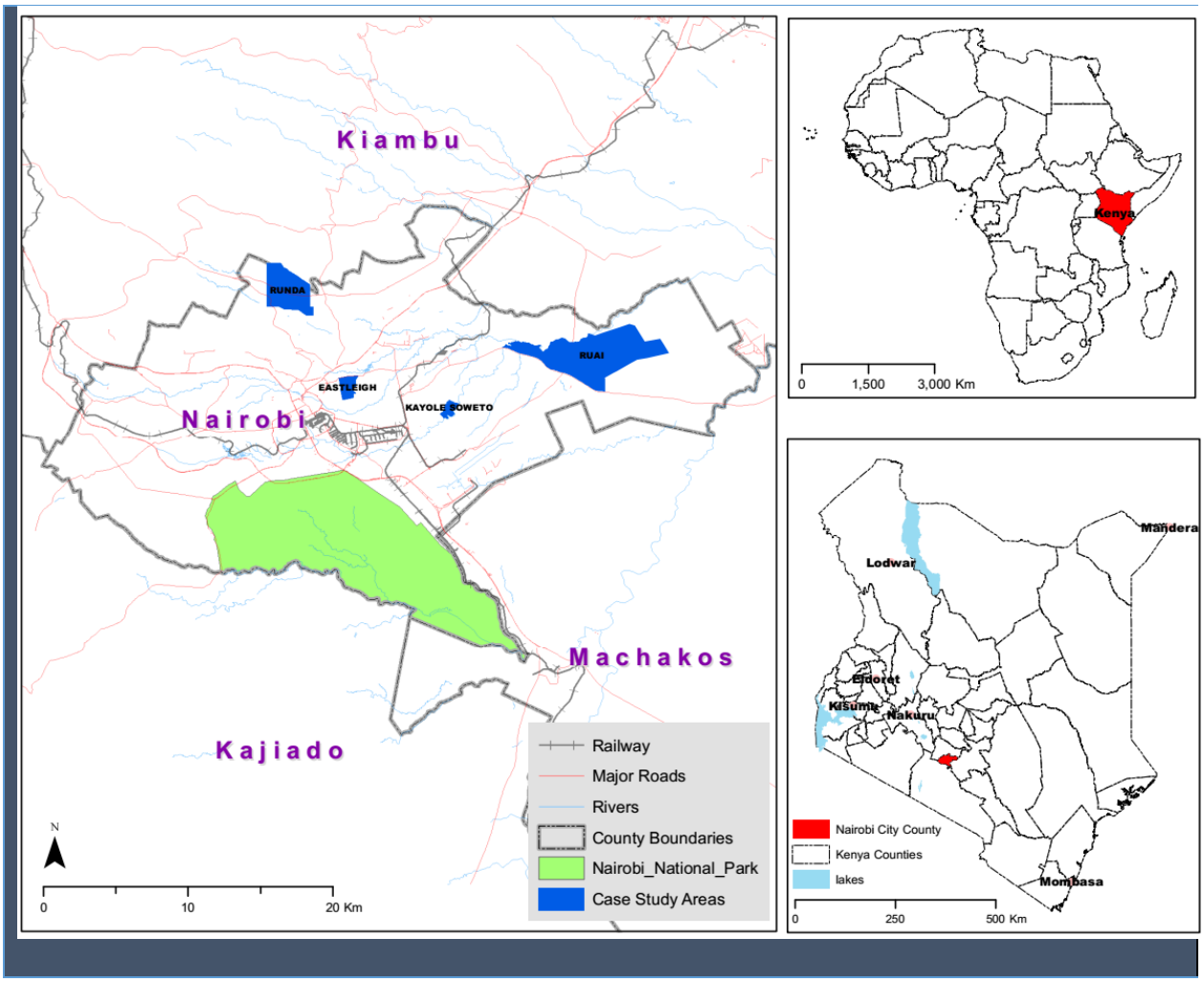

Figure 1-1: Location of the case studies within Nairobi
Source: Drawn by the author based on Google Map 2013

1.5.3 Research methods: data collection and limitations

In carrying out data collection for my research, I relied on qualitative methods of data gathering. Neuman (2003) strongly emphasizes on data gathering methods that are sensitive to context through firsthand experience, truthful reporting and conversations from insiders' perspectives. Specifically, I used ethnographic methods of data collection in the four cases. This consisted of in-depth interviews, semi-structured interviews, small focus group discussions and participant observations. These methods promoted detailed dialogues

with respondents (Howe 2004; Elliott and Timulak 2005). I developed and nurtured personal contacts with study participants and their active engagement within their contextual living spaces over the entire period of conducting fieldwork and writing of this dissertation. Building a partnership with my study participants through principles of inclusion and dialogue (Howe 2004) helped to deepen insights into the data and context of the study (Tuli 2010).

I conducted in-depth interviews with respective community key respondents, including village elders and area chiefs. Their role was crucial in explaining the local histories and trajectories of urban development in their localities through their own personal and official administrative insights and documentation over time and space. I recorded the conversations, where permission was granted, using an audio recorder. Most of the conversations were done in Kiswahili, which made the interviews more flexible and easily understood by the respondents. In addition, I held open-ended interviews and conversations with local inhabitants of Eastleigh, Kayole Soweto, Runda and Ruai settlements. Apart from administering open ended-questionnaires, I also organized smaller focus group discussions to stimulate ideas from the participants and enhance their voices on how they collectively experience water supply as residents of their respective neighborhoods.

As concerns official data sources, I carried out several semi-structured interviews with key informants from government institutions, utility companies and residents associations. Key respondents in this regard were drawn from relevant offices namely, (i) the County Government of Nairobi [the Department of Housing, Lands and Physical Planning, the Department of Urban Design and Development, the Department of Environment and Water Resources]; (ii) The Nairobi City Water and Sewerage Company (NCWSC) [headquarter offices at Industrial area, the Informal Settlement Regional Office at Kariobangi, and on-site offices in selected case settlements; (iii) The Athi Water Service Board [Engineering Department]; (iv) The Water Service Trust Fund [Urban Window]; (v) The Water Service Regulatory Board [Water Action Group]; (vi) The Runda Water Limited [Managing Director and the Technical Manager]; and (vii) The Runda Residents Association [the General Secretary].

On the other hand, I extensively used participant observations to capture typologies of development on the ground and modalities of water supply within the case settlements. These were captured through photographs, note taking and typomorphological mapping. Participant observation was an integral method in understanding the breadth and complexities of water supply in localized contexts within Nairobi. Here, I was

able to keenly observe different groups as they went about in search of the precious commodity from among stationery and mobile water vendors, exchange of transactions, modes used for carrying and storing water as well as the everyday activities of study participants. This involved day-to-day immersion into participants' life-situations in their natural settings to enhance in-depth understanding of the social, economic, physical and cultural context of people's activities (Dewalt and Dewalt 2010).

Review of secondary literature from project documents, relevant government policy documents, newspapers, websites and published academic material provided additional useful data sources for this research. These data are presented here in the form of logical narratives, direct quotations, footnotes, maps, and pictures. The specificities of these methods are elaborated in each of the cases advanced in the subsequent chapters of the Dissertation.

1.5.4 Legal and ethical issues

In carrying out data collection, there were legal and ethical issues that I was subjected to as a researcher.[1] One was to acquire a research permit to allow me to conduct fieldwork in Nairobi (see appendices). Accordingly, I obtained a research permit from the issuing authority, the National Commission for Science, Technology and Innovation (NACOSTI). The bearing of the research permit was however not a guarantee for accessing all data sought in government offices and other institutions and organizations. Access to certain official records, maps and documents was a difficult exercise as the filing and storage systems in government offices is largely manual and disorganized. This made identification of some of the requested files impossible or time consuming. Also, arranging appointments with key officials was a tricky affair as officials regularly operate outside their offices, often attending meetings elsewhere.

In other places, access to offices for purposes of data collection was flatly denied (I was turned away at the gates of the World Bank Building in Upper Hill, for example). The highly bureaucratic procedures of accessing and obtaining data and interview appointments thus required time and patience, a luxury I could hardly afford within the constraints of time and other resources. Another challenge was refusal to record oral interviews by a few respondents who withheld their consent to do so. This challenge was however tackled by note-taking, which was largely preferred by most interviewees. Yet again I encountered petty thieves in the streets while conducting field work. I lost my camera, voice recorder, notebook and other documents containing field

[1] https://www.nacosti.go.ke/

work material in such incidences in Eastleigh and other study sites. Although I was able to recover some of the documents later on, I was not able to fully reconstruct original interviews and captured moments gone with the camera. All in all, the cumulative data gathered through a total of six months of fieldwork has been sufficient in answering the research questions I set out to cover in this study.

1.6 Dissertation outline

Following this Introduction, the rest of the dissertation is laid out as follows.

Chapter 2: Historical evolution of the networked water infrastructure in Nairobi

This Chapter provides a historicized account of the co-evolution of the networked infrastructure for water supply in Nairobi. The Chapter intertwines the narrative of the extension of the networks with wider political economic dynamics and urbanization patterns influencing investments in urban infrastructures. The roles of different institutional actors ranging from the colonial administrators, international monetary institutions, the World Bank and the Kenyan state, among others, is well explained to demonstrate the modalities of transplanting of 'modern' ideologies and their actual influence on the city's development. Of importance is the revealing of power structures that direct and shape the development of the water networks and accompanying structures such as dams and institutional frameworks for water governance. Through this post-colonial narrative, it becomes clear that old colonial policies of racial segregation that disenfranchised Africans in enjoyment of urban services is being perpetuated by current state agencies in the form of political and economic class at the expense of a large fraction of the urban population living in informal settlements and peri-urban areas. The Chapter lays a strong foundation for the subsequent empirical cases.

Chapter 3: Living in the interstices of a networked city: actually existing water supply modalities in Eastleigh, Nairobi

This Chapter focuses on the imbricated modalities of water supply amid rapid socio-spatial transformation in the Eastleigh neighbourhood of Nairobi. Eastleigh still relies on an outdated water infrastructure system built in the 1950s, despite changes in building densities and population growth over the years. In the meantime, population living and working in this neighbourhood are getting increasingly marginalized in terms of water infrastructure and service provision. This marginalization has over time spawned a complex coexistence of both formal and informal practices from diverse actors in the urban development process. Residents of Eastleigh have resorted to alternative modes of water supply such as water truck deliveries and small-scale

vendors, which while contravening the official servicing policies of the area, meet the daily water needs of the population. The Chapter therefore identifies a mismatch between the 'modern infrastructural ideal' and grounded realities of water service provision in Eastleigh. The point of encounter and contestation between these various rationalities—the interface—is espoused as a zone where different forms of translation of the 'modern infrastructure ideal' by different actors is manifested through day-to-day interactions with socio-technical systems of water service delivery.

Chapter 4: Enclave infrastructures: the paradox of water infrastructure and service provision in Runda, Nairobi

This Chapter analyses a privatized and decentralized networked infrastructure system in a residential enclave in Nairobi. Whereas this kind of infrastructure arrangement has been commonly referred to in the literature as 'premium networked infrastructure', limited contextual studies have been carried out to understand the varied ways of producing and functioning of premium infrastructure systems within urban enclaves. The example of water supply system in Runda, one of the affluent residential gated communities in Nairobi is advanced here. The case makes two important contributions. First, it challenges the dominant assumptions that underlie the networked infrastructure model, particularly that of integrating urban space through equal and monolithic service provision by a monopolistic public utility. Second, it questions the 'premiumness' that is attached to the construction, operation and governance of networked enclave infrastructures. Through the case, it becomes evident that enclave infrastructure systems are heavily shaped by power contestations among various actors involved in the urban development process. The private sector, real estate speculators and gated community residents' associations are all positioning themselves as powerful agencies in urban planning and infrastructure governance under the gaze of state planning authorities. However, private infrastructure governance is fraught with externalities that overwhelms its efficient service delivery. There is also the issue of gated communities' limited power in decision making on urban development matters beyond their boundaries.

Chapter 5: Towards collaborative infrastructure planning? The co-production of water supply in Kayole Soweto, Nairobi

This Chapter introduces a co-production approach to improve collaborative planning practices in the delivery of water infrastructure services among low-income settlements in Nairobi. Co-production, it is argued, promotes active engagement of local communities, alongside other external stakeholders, in the design and

implementation of public services. Using the case of a recently implemented 'social connection' policy in Nairobi's low-income area of Kayole Soweto, the Chapter demonstrates how multiple stakeholders can be engaged, through co-production, in empowering communities previously marginalized in terms of urban water supply. The Chapter's argument is that co-productive activities trigger institutional and governance changes by radically innovating unconventional models of infrastructure and service delivery. Co-production thus acts as an emancipatory vehicle for improving urban governance by including the urban poor in public infrastructure service provision, particularly within rapidly transforming cities of the Global South.

Chapter 6: Beyond borders: peri-urban water supply in Ruai, Nairobi

This Chapter focuses on the dynamics of water supply in peri-urban Nairobi. Peri-urban areas are experiencing the greatest water stress as they are located far from the central water networks, yet they are rapidly developing into urban centres of the (near) future. In these areas, provision of water through the conventional model of networked infrastructure is confronted with local spatial and socio-economic dynamics that pose challenges for both city authorities and local inhabitants. As city planners and utility companies are constrained in controlling development and expanding infrastructure networks in tandem with fringe development, peri-urban residents are forced to mobilize alternative socio-technical assemblages to support their daily lives. As demonstrated by the case of water supply in Ruai, the multiplicity of socio-technical arrangements that characterize water supply in such spaces are heavily laden with power relations that enfranchise and disenfranchise different social groups living there. This produces and reproduces new unequal geographies of water supply and marginalization of the poorest social groups. The chapter argues for integration of peri-urban infrastructure into the core of (peri-)urban planning, in order to balance power relations and enhance infrastructure benefits by those living in fringe areas.

Chapter 7: Revisiting the networked city: towards "CO-Heterogeneous Infrastructure Configurations?"

This Chapter brings together the discussions from the empirical chapters and merges them with the theoretical debate on urban infrastructures. Specifically, the Chapter re-problematizes the continued use of conventional models in the water supply for Nairobi based on the empirical chapter findings. The re-problematization sets a robust foundation for charting a holistic and situated infrastructure lens, the "CO-Heterogeneous Infrastructure Configurations (CO-HICs)" that may help in the present and future understanding of urban diversities and heterogeneous socio-technical configurations of service provision in

contemporary cities. The CO-HICs counters the long sold argument of a homogeneous, universal, monolithic and monopolistic infrastructure system that is no longer useful as an accommodative analytical lens by advocating for heterogeneity at the core of infrastructure investigation in contemporary cities. Fundamentally, the Chapter illuminates urgent socio-political and technical issues that are relevant not only in contributing to the larger urban scholarship on infrastructures, but also for practical application by urban administrators, planners, engineers, policy makers, utilities, private sector, users, the state and its agencies, international financiers, donors and development actors involved in the urban development processes.

2. HISTORICAL EVOLUTION OF WATER NETWORKS IN NAIROBI

2.1 Overview

This Chapter lays out the historical foundation for the construction of a networked water infrastructure in the post-colonial city of Nairobi. Attention is paid to the contextual intricacies involved in the superimposition of the networked ideal during the colonial and post-colonial water regimes in Nairobi. More importantly, a deeper look at the structural dynamics behind the water networks provides a comprehensive understanding of how Nairobi, as a city, has developed over time and space. The critical role of power is explicated through the transfer of modern ideologies in shaping infrastructure governance systems and planning models as different interests are pursued by a diversity of urban actors ranging from international financiers, donors, national state, local authorities, private actors and corporate interests. In addition, the Chapter historicizes the legal, policy and institutional changes for water supply since the birth of Nairobi to present. The history is embedded within wider socio-political and economic processes as the water sector did not evolve in isolation from these dynamics.

2.2 The colonial water regime in Nairobi

2.2.1 Watering the railway town

Nairobi's water infrastructure system is traceable to the colonial period when the British extended the Uganda Railway to reach Nairobi in 1899 (Nyanchaga and Ombongi, 2007; Blomkvist and Nilsson 2017). The location of the railway depot in Nairobi was deemed suitable on account of its topographical features, which were enhanced by the presence of the Nairobi River for ready supply of water. Maasai herders, the original settlers of the site, called the place *Enkare Nairobi*, meaning a 'place of cool waters.' The community had long fetched water from nearby rivers, streams and natural springs, which were also watering holes for their cattle. These remained central sources of water, with supplements from rain water harvesting during the rainy seasons in the course of founding Nairobi as a railway town. Soon after, customary authority and African institutions (the Maasai) involved in control of natural resources were eventually eroded under the colonial rule (Nyanchaga 2016).

In 1905, the British declared an area of about 18 square kilometers as constituting the Nairobi railway town (figure 2-1).The new changing character of the landscape and incoming of steam engines, the railway engineers and Europeans soon saw the need to install a 'modern' system that would supply water to new

housing quarters and to support the running of machines (Blomkvist and Nilsson 2017). The European population had increased from initial 559 to 10,400 (Nyanchaga 2016). Disease epidemics, for example in 1902 and 1907 accelerated the need for an improved water system (ibid.). Bringing experience from Europe, the railway engineers first abstracted water from Chiromo area and through gravitational flow, supplied water to the European and railway workers' quarters, as other areas continued to rely on surface water sources. The Chiromo water project, among others, should be seen as part of modernization initiatives set in motion by the colonial masters, as well as a response to the public health discourses of the late nineteenth century industrialization in the European metropolis (Njoh and Akiwumi 2011).

The early development of Nairobi had structural and socio-political implications that would subsequently shape the distribution of infrastructure services. To begin with, the colonial administration had used the concept of 'terra nullius' to acquire large tracts of native land, either as private freeholds or under long-term leases of 999 years, in total disregard of local community needs (Oyugi and Owiti 2007). The British conceived Nairobi as a European city from the onset, where Africans were tolerated only for their labour force (Amis 1984; Huchzermeyer 2011). Immigration, housing and labor of Africans were strictly regulated through use of pass laws that only allowed male workers into the urban area (Gatabaki-Kamau and Karirah-Gitau 2004). Consequently, the colonial administration sanctioned a spatial segregation policy based on race (figure 2-1), which was further reinforced through planning laws and exclusionary zoning regulations (K'Akumu and Olima 2007). As such, Nairobi was organized into distinct zones comprising of the railway town, Indian bazaar, European business and administrative center, railways quarters, washerman's quarters, European residential suburbs and the military barracks.

Following the racial zoning of the time, Nairobi was divided into four distinct residential districts (Oyugi and Owiti 2007). The highlands to the West and North formed the European zones; part of the North and East was designated as Asian enclaves, while the Eastern and Southern parts were designated as the African zone. These racial zones later became entrenched in subsequent spatial plans implemented during the colonial administration and accompanied by high planning standards that later proved unattainable by the majority African population (Amis 1984).The objective was to protect the health of colonial officials by avoiding contamination via separation of settlements through the construction of green belts or cordon sanitaires (Njoh 2008).Theses zoning regimes further excluded indigenous communities from the enjoyment of the city's

infrastructure services by enhancing segregation, enclaves and spatial limits to the interest and advantage of the European settlers (Owuor and Mbatia 2008).

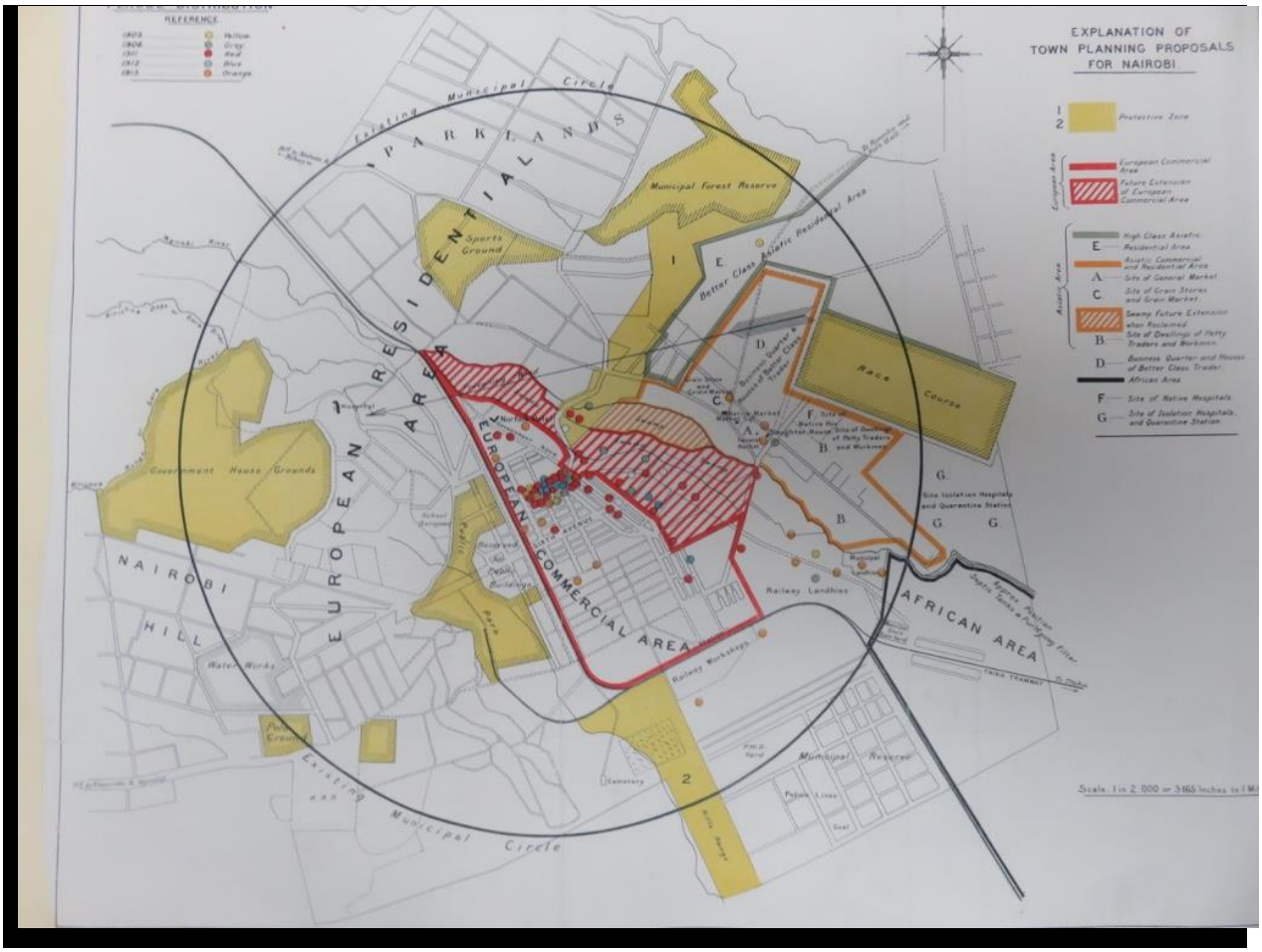

Figure 2-1: Colonial zoning according to racial divides
Source: British National Archives, 1914

By 1906, increased water needs from the growing number of European executives, railway workers and other members of the working class, besides running of locomotives' steam engines necessitated another abstraction of water by the Railways engineers from Kikuyu Springs, 13 kilometers away, (Ledant et al. 2013; Nyanchaga 2016). The engineers replicated the British networked model by abstracting water into a central treatment plant on site before channeling it into the water mains for subsequent distribution to consumers. However, the nascent town experienced perennial water shortages, causing the Railway Corporation to restrict water use by way of meters for the very first time in 1908 (Nyanchaga 2016). Meters and other control measures such as prohibition on use of hosepipes and garden watering were meant to control use of scarce water more than billing and revenue collection. In the following decade, there were reported incidences of

compromised fire-fighting tactics and plague outbreaks as water scarcity worsened (Smart 1950; Ledant et al. 2013). To control the spread of diseases, the colonial administration destroyed the Indian Bazaar, which had been blamed for filthy conditions that spread disease. Due to the grave water situation facing the city, other alternative sources of water such as drilling of boreholes and development of decentralized water treatment plants were sought at different parts of Nairobi. An example is given of the Muthaiga Water Company, which emerged as a private company that supplied water to around 500 households (Colony and Protectorate of Kenya 1913-1923).

2.2.2 Municipalization of water in Nairobi

In 1922, Nairobi was made a municipality, and in accordance with the municipal ordinance, the local authority took over the water supply function for the entire township (Colony and Protectorate of Kenya 1930). In pursuit of centralizing the water supply, the authority bought off infrastructure assets from the Railway Corporation and other then existing private providers such as the Muthaiga Water Company, thereby establishing a monopoly (Nilsson and Nyanchaga 2008). At the same time, the township was rapidly growing given the administrative and social needs of the increasing European population in the Kenyan Colony. More Africans from the native reserves were also streaming into the township as laborers.

The increasing demand for water amid persistent water shortage saw the municipal authority install yet another water project from a more distant (25 kilometres) Ruiru River in 1936 (ADB 1998). The abstracted water from this river was (and still is) channeled to Kabete treatment plant that was completed in 1938 (Nyanchaga 2016). Following frequent droughts experienced throughout the colony, the municipal authority kept on augmenting the city's water supply in the subsequent years. For instance, in 1953, the council built the Nairobi Dam on the Ngong River in the outskirts of the city (Kibera) as a reservoir of potable water supply (Rotich et al. 2006).The municipal council also complemented the Ruiru intake with a dam structure in 1950, to bring the yield of Ruiru to 21, 400 cubic meters (Nyanchaga 2016). Later on in 1956, an even more distant source was considered that saw the authorities build Sasumua Dam on the Chania River, 40 miles North-West of Nairobi (ADB 1998).

The Sasumua Dam brought the average available water per person per day to 140 litres across Nairobi (Blomkvist and Nilsson 2017). Nonetheless, while these water projects tried to keep pace with the growth of the city from demographic expansion and economic functions, the racial policies of the time continued to

favor and disfavor different groups across the city. For instance, in 1907, every person was entitled to about 40 litres of water per day. However, by 1934, the design demand was increased to above 220 litres per capita per day for the European population, 135 liters for the Asians while the Africans were allowed about 90 litres (Blomkvist and Nilsson 2017). The differentiation of the consumption levels inscribed modernity and progress of imported engineering standards, thereby affecting ideals and norms of water supply in Nairobi (ibid.).

2.3 The post-colonial water regime: a case of (dis)continuity of colonial legacies?

With Kenya attaining political independence in 1963, restrictions on movement of Africans to urban areas was lifted, resulting in massive rural-urban migration (Gatabaki-Kamau and Karirah-Gitau 2004). Nairobi's population rose from 343, 500 in 1962 to 827, 800 in 1979 (Amis 1984). This rapid growth, amid unequal distribution of infrastructure as propagated by the colonial policies, became a huge challenge for the newly independent government. Kenyans expressed hope for integration of urban residents and developing 'one city for all' by overcoming the segregation legacy of colonial rule (Owuor and Mbatia 2008). However, city development was still guided by spatial plans and policies developed by the colonial masters. For instance, the spatial plan of 1948 remained in force until 1978 when the Nairobi City Council prepared a metropolitan growth strategy which was meant to guide development of the city up to the year 2000. However, the implementation of this plan was limited by budget constraints and inefficiencies of the NCC (Nyanchaga 2016). The result was uncoordinated and unregulated spatial growth of the city without commensurate infrastructure development (Syagga 2011; Oyugi and Owiti 2007).

In terms of water policy, the 1935 colonial policy was only replaced later by the Water Act of 1972, which vested all water resources in the Ministry of Water and Irrigation (MWI). The day-to-day provision of water and sanitation services was delegated to local authorities. As such, the Nairobi City Council (NCC) became responsible for the planning, designing, operating, supplying and billing of water services through its Water and Sewerage Department (WSD). However, it was not long before the NCC was overwhelmed by the sheer demand for water in the city as accumulation of large billing backlog, huge financial arrears, leakage and illegal connections crippled its operation (Ladent et al. 2013). The non-revenue water, meaning water lost due to leaks, pipe bursts and unauthorized consumption rose sharply from 17% in the 1970s to 40% by mid the 1980s (Nyanchaga 2016).

Notwithstanding, the city was wrestling with providing basic services to the bulging population that had already overwhelmed existing infrastructure capacities (figure 2-2). The City Council augmented yet again the capacity of the Sasumua Dam in 1968 (Nyanchaga 2016). The total city's water supply capacity amounted to 88,000 cubic meters per day, surpassing the estimated demand of 61, 000 cubic meters per day (Ledant 2013). However, this capacity was soon outstripped by the unstoppable growing demand. At the time, the post-colonial state was experiencing economic hardships with little or no resource support to the local government.

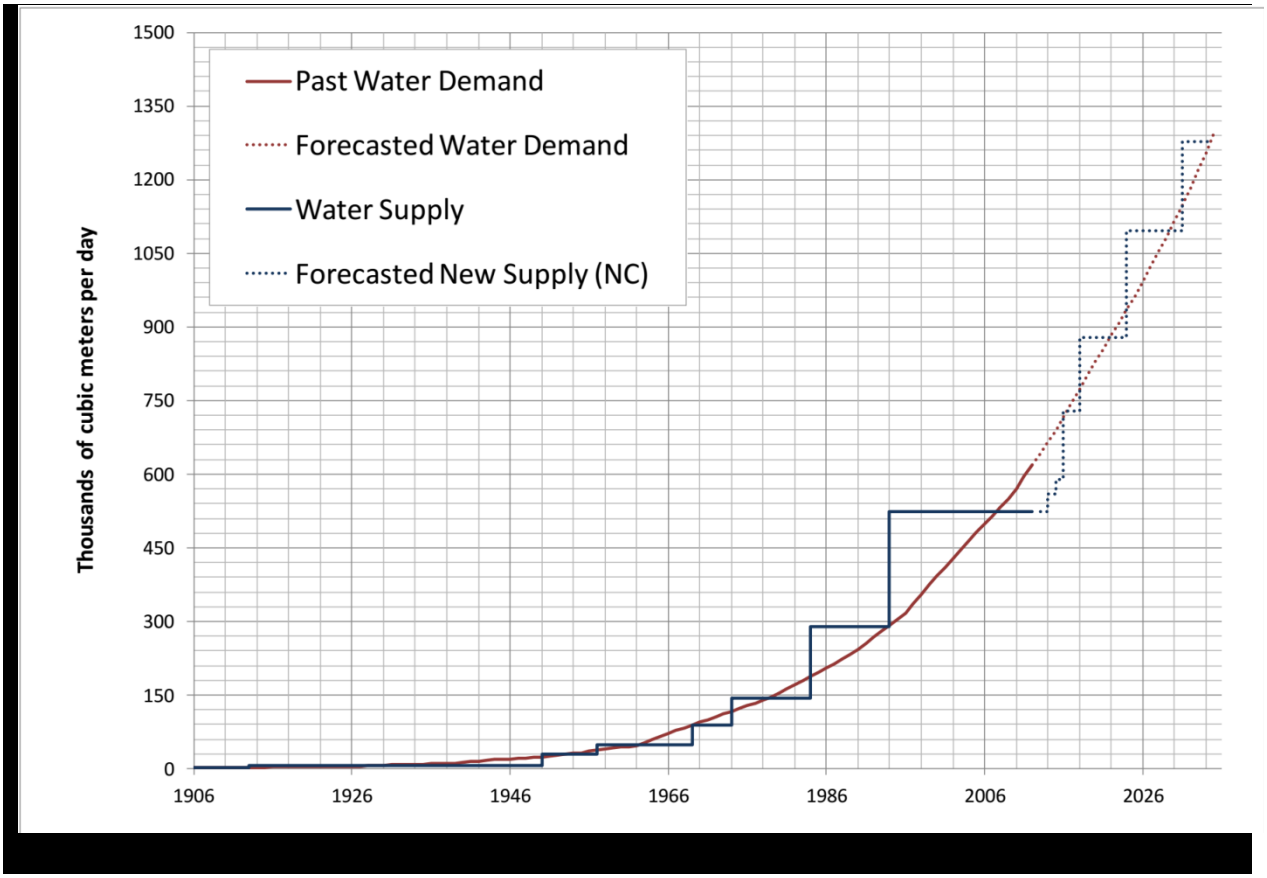

Figure 2-2: Supply and demand of water in Nairobi 1906-2026
Source: Ledant et al. 2013

2.3.1 The reign of international financiers

The 1970s saw the increasing role of international financiers in lending development loans to struggling economies such as Kenya. Accordingly, the Nairobi City Council, with financial support of the World Bank, implemented three major water projects that were spread over thirty years (World Bank 1996). The first water supply project was implemented between 1972 and 1976, and involved a new treatment plant at Ngethu that

tapped water from the Chania River to the East and downstream from the Sasumua Dam (ADB 1998). The second project (1978-1984) carried on with works earlier started at Ngethu to meet water supply needs of the city up to 1988 (ibid.).

With further support from the African Development Bank, the European Investment Bank, the Overseas Economic Co-Operation fund of Japan and the central government, the Nairobi City Council significantly upgraded Nairobi's water supply by constructing Thika Dam, 60 Kilometres north of Nairobi (Syagga and Olima 1996). Thika Dam, popularly known as the third Nairobi water supply project was carried out between 1985 and 1995 and was the biggest water project ever undertaken. The project was designed to hold 70 million cubic meters of water and cost about US US$30.5 (Syagga and Olima 1996). Thika Dam was expected to increase the available water yields to 460,000 cubic meters per day, up from 194,200 cubic meters (ibid.). This yield was meant to sustain Nairobi's growing water needs to the year 2005. All together, the three undertakings increased four folds the raw water supply to Nairobi, besides upgrading the network distribution system.

Despite the many capital-intensive water projects implemented, the Kenyan state through its various planning and implementing agencies reproduced colonial engineering water practices that continued to serve the interests of a minority economic and political elite. In place of race, socio-economic and political power gradually became the new determinant of resource redistribution, often to the disadvantage of a growing poor majority huddled in un-served informal settlements. As a result, it is the economic and political elite occupying wealthy neighborhoods usually in the former European residential quarters that benefited from improved water supply, as opposed to majority of the urban population occupying the former African zones to the East of the city. Notably, the Nairobi water supply projects did not include extension of distribution networks into low-income areas that hosted about 60% of the city residents (ADB 1998). As observed, the struggle to quench the city's thirst majorly resulted to search for further and further sources of water in the outskirts of the city without significant expanding the distribution and access of water to the majority low-income areas (*figure 2-3*). On the other hand, the rapidly and informally developing areas presented complex physical, socio-economic and legal conditions in relation to provision of water through standardized in-house piped and metered connections to the central networks (Nilsson and Kaijser 2009).

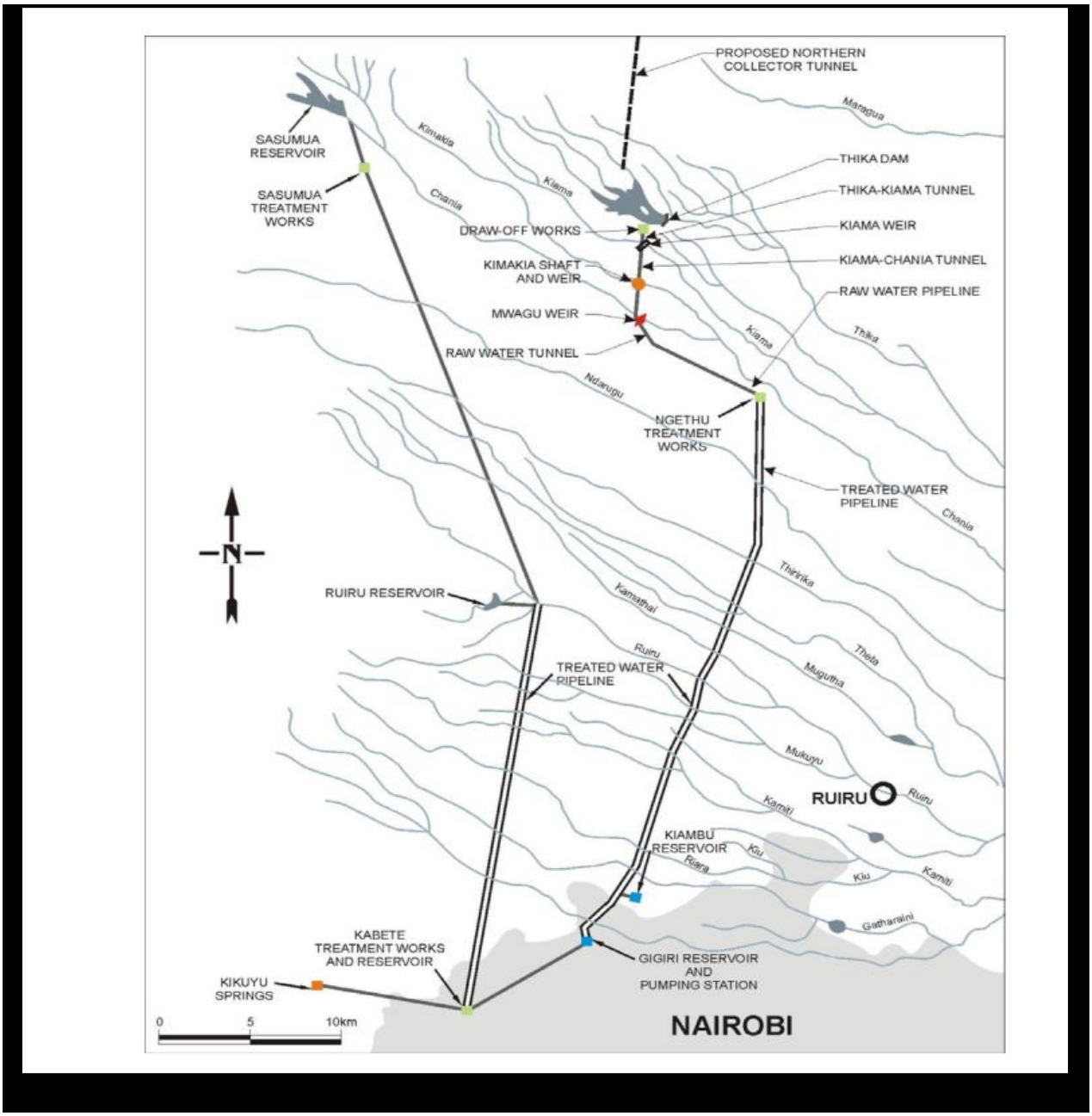

Figure 2-3: Current water sources for Nairobi
Source: BRL and Seureca (2010)

2.3.2 SAPs and water reforms of 2002: implications

The entrenched inequalities in water supply was perpetuated yet again by the adoption of the externally instigated structural adjustment programs (SAPs) of the late 1980s. The divestiture promoted by the World Bank set in motion the privatization process in the water sector not only in Kenya but across the developing nations (Bakker 2003; Budds and McGranahan 2003; McDonald et al. 2005). Accordingly, the Kenyan state

embarked on reconstituting its water legislation in the late 1990s to fit within the global shift in the public policy model (Kemerink et al. 2016). The global positioning was deemed necessary by the Kenyan bureaucrats in the hope that material outcomes aligned with the political ideals and ambitions of the reform process would be achieved (ibid.). However, as we shall see below, the reforms had partial focus on institutional changes while largely ignoring material projects and felt-needs such as access to water supply by majority population and diverse geographical conditions of water use, demands and (un)availabity.

The ultimate implication was commercialization of water services in the name of improving economic viability of water utilities (K'Akumu 2006). It was argued that commercialization would improve service delivery and help in the rehabilitation and expansion of existing water schemes through cost recovery (K'Akumu and Appida 2006). The sector reforms culminated in the formulation of the Water Act of 2002 that provided the legal basis for the creation of new institutions for the management and delivery of water services in Kenya (Figure 2-4). In accordance with the Water Act, water resource management, policy formulation, regulation and supply functions were separated and the functions vested in different institutions. As such, regulation of water services is today the responsibility of the Water Services Regulatory Board (WASRB), while control of water resource use is managed by the Water Resource Management Authority (WARMA), both of which are national bodies. Meanwhile, the Ministry of Water and Irrigation is in charge of formulation of overall water policies for the country.

Following the implementation of the water policy, the Nairobi City Water and Sewerage Company (NCWSC) was incorporated in 2003 as a water service provider within Nairobi City. NCWSC is a wholly owned subsidiary of the County Government of Nairobi (then NCC).[2] In addition, the Athi Water Service Board (AWSB) is today the undertaker of capital investments and asset holder of Nairobi's water infrastructure. Under this arrangement, the NCC transferred its assets to the AWSB through a lease agreement. The AWSB in turn sub-leases the assets to the NCWSC, who operates the system on a day-to-day basis. This operational framework is configured in a tripartite agreement in which the NCWSC pays 20% of its revenue to the AWSB (Figure 2-5).The AWSB in turn pays 1% of its revenue to the WASREB. The NCC on its part receives 50% of the total revenue collected by the AWSB (Ledant et al. 2013).

[2] The changes were effected by the constitution of 2010

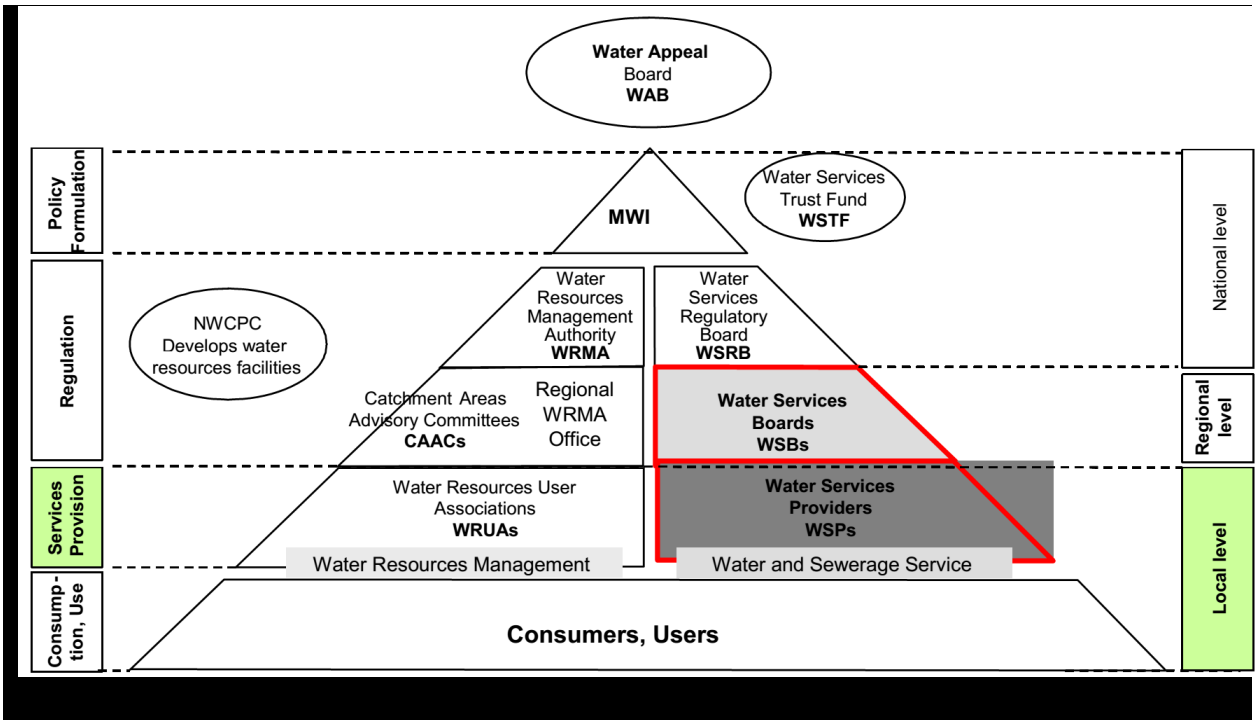

Figure 2-4: Institutional framework for water supply in Kenya
Source: Adapted from the Water Act of 2002

Despite the water sector reforms, little progress has been recorded in structural transformation, particularly in matters concerning efficiency of utilities and closing the inequality gaps in water supply. Although the NCWSC is supposedly an autonomous institution, its operations are subject to political and economic interference from the central and county governments (K'Akumu 2006). Vested interests and lack of political good will have both curtailed realization of efficiency of the water utility. From the tripartite lease agreement (Ladent et al. 2013), the NCWSC's operations are hindered by a bureaucratic financial arrangement that stifles re-investment of collected revenues to improve water infrastructure conditions. The cost recovery principle and commodification of water services also mean that the water utility only cherry pick profitable areas that promise high returns, leaving out less profitable areas such as the expanding informal settlements underserved, if at all. Left to fend for themselves, informal settlements dwellers have had to rely on illegal water connections and unscrupulous water vendors for their daily needs. It is worth noting that the water utility inherited a dilapidated and aging water network from previous regimes dating back to the colonial days, with little or no repair and maintenance done over time.

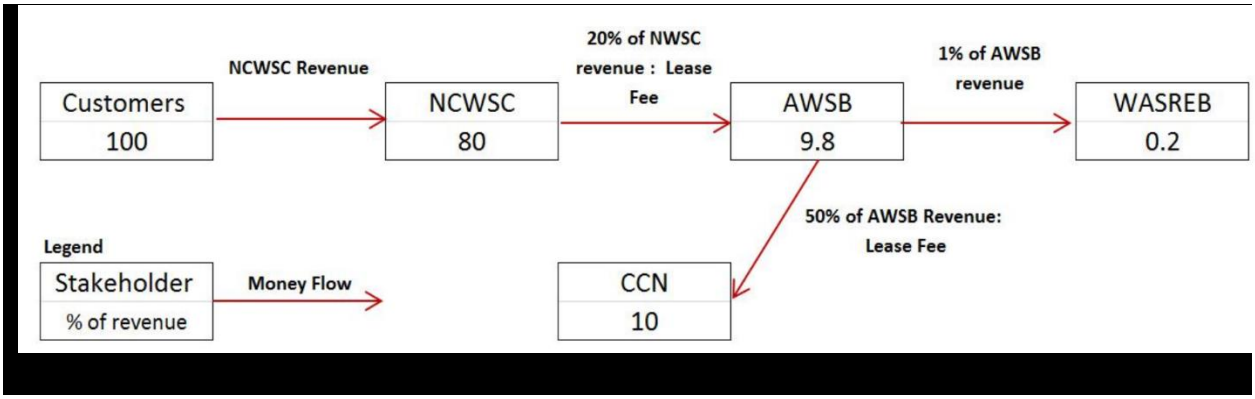

Figure 2-5: Financial arrangements of the Nairobi tripartite water institutions
Source: Ladent et al. 2013

2.3.3 Water as a basic human right

In 2010, the Kenyan Constitution specifically identified water as a basic human right, under the Chapter on the Bills of Rights (GOK 2010). This constitutional provision has changed dynamics in the water sector by promoting non-discriminatory and pro-poor policy approaches in urban water provision. Although some progress can be sited in areas of institutional restructuring to accommodate informal settlements in official water supply (NCWSC and AWSB 2009), there still remains a lot to be done to improve the water situation in Nairobi. With the current population of Nairobi estimated to be 4.5 million (KNBS 2013), only 50% of the city population have access to piped water with the rest who consists of the poorer groups obtaining water from kiosks, vendors, illegal connections and boreholes.[3] The unconnected population end up spending up to twenty times the price of the official water tariff (Ledant et al. 2013).

The current design capacity of the city's water supply is 524,800 cubic meters per day, a mark that was long surpassed by water demand back in 2007 (Ladent et al. 2013). The daily water deficit is estimated at 125,000 cubic meters (ibid.). The poor state of distribution networks contribute to the loss of about 42% of the water supplied in the city through leakages, illegal connections, errors in meter reading and unbilled consumption (Chakava et al. 2014). Coupled with the burden of rapid urbanization under resource constraints, the County Government of Nairobi through the NCWSC is unable to cope with water demand of the burgeoning population. This begs the question whether the normative constitutional right to adequate and clean water supply is enough to bridge the deficit when on the other hand, water is treated as a traded commodity

[3] https://www.nairobiwater.co.ke/about.html accessed on 21/11/2015

operating under market mechanisms of demand and supply, and its distribution wrought by income discrimination significantly disadvantaging the reach of the majority low-income population.

2.3.4 Ongoing water projects

To offset the present water deficit, the AWSB, with additional financing from the World Bank, is presently implementing a new water project, the Northern Collector Tunnel (NCT) phase I (AWSB 2015). This scheme was initially planned as part of the third water supply project for Nairobi, back in 1998 and was envisioned to be complete by 2010. However, insufficient funds and political interference led to its stalling until now (AWSB 2015). The NCT involves river diversion and related intake hydraulic works at Maragua, Gikigie and Irati rivers, as well as river outlet at Githika River, all of which will convey intercepted water to the existing Thika Dam. The objective is to increase water supply in Nairobi by 121, 000 cubic meters per day (AWSB 2015). Even with anticipated completion of this project, predictions already show that the supply will not catch up with the estimated demand (Ledant et al. 2013; Ledant 2013), as the city continues to urbanize rather fast alongside widening inequalities against limited water capacity.

Meanwhile, the NCWSC employs water rationing, a mechanism that helps to distribute the available water to different regions at different times as the company awaits system refills for onward channeling to different corridors. As expected, the manipulation of water valves is wrought with socio-economic bias with wealthier neighborhoods and the central business district receiving water at more frequencies compared to lower income neighborhoods in the Eastlands and peripheries of the city. Overall, the city is divided into six administrative regions in terms of water supply, namely Northern, Eastern, North Eastern, Central, Southern and Western. These regions receive water at different times according to a pre-prepared rationing schedule. Water rationing has resulted in the emergence of unregulated market alternatives for water supply, as well as over reliance on coping mechanisms such as storage tanks that accentuate differential access to the essential commodity. Not to mention increasing corruption allegations where officials of the NCWSC create artificial water shortages to give their water bowsers ventures economic boost.[4]

[4] https://www.standardmedia.co.ke/article/2001246066/opinion-water-shortages-need-permanent-solution accessed on 30/07/2017

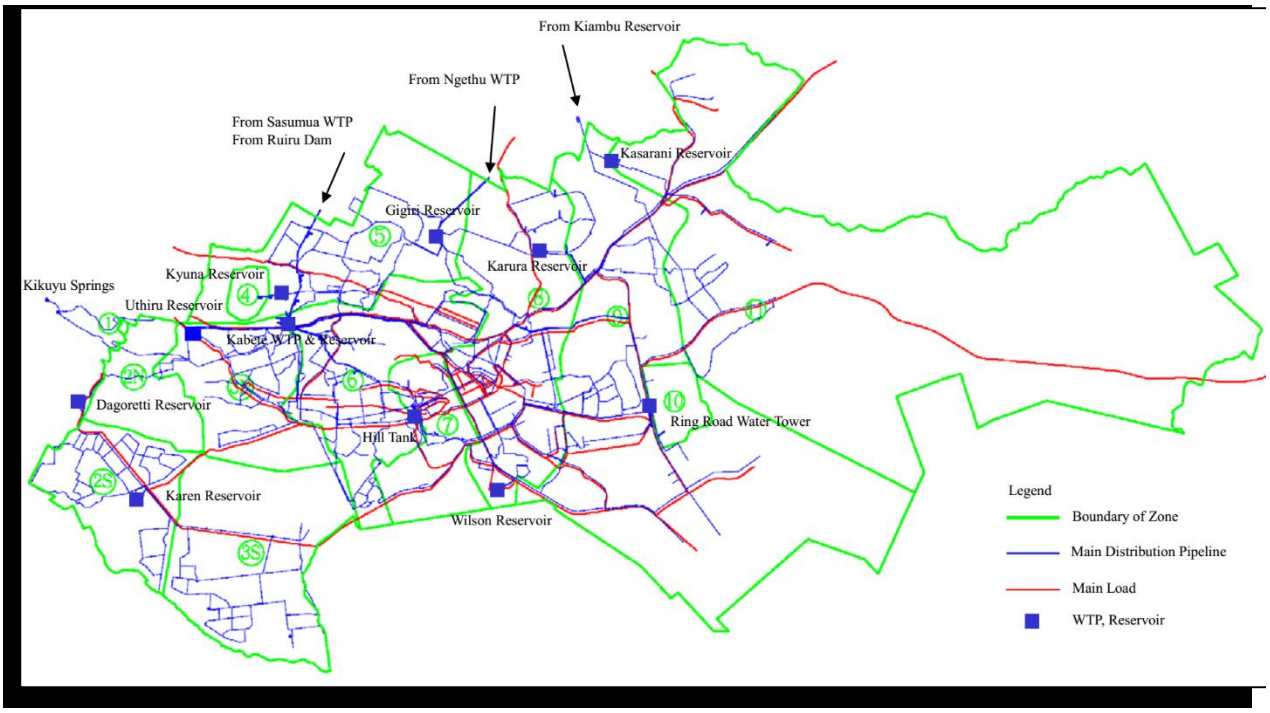

Figure 2-6: Distribution of water networks within Nairobi[5]
Source: JICA 2014

2.4 Concluding remarks

This Chapter has systematically elaborated the water supply regimes in Nairobi throughout the colonial and post-colonial city administration. The analysis has demonstrated how water infrastructure configurations are constituted by the interplay between normative planning and policy models borrowed from Western regimes, and disparate infrastructural options for water supply in Nairobi. The existing water situation can be attributed to a sequence of historically produced dynamics of unequal social and power relations in the policy formulation and urban development processes, which in turn (re)shape and (re)produce unequal geographies of water supply across the city. The latest water sector policy reforms of 2002 was largely concerned with institutional changes that can be seen in light of neoliberal ideologies circulating at the time, and which did little to transform infrastructure development. The technological choices and infrastructure standards based on the networked city have exclusively been preserved from the colonial era (see for example Nilsson and Nyanchaga 2008; Nilsson 2016). As such, both legal policies and planning models are based on circulating Western ideologies that mostly serve the interests of the elites at the expense of ground realities in Nairobi. The resultant is an intrinsic plural, unequal and different modern realities as opposed to a homogeneous city-

[5] Notice the Eastern side has the least coverage with more concentration at the central and Western area

, water-scape and infrastructure configuration claimed by externally-driven blueprints development ideologies.

In order to better understand the complexities of the production of Nairobi's waterscape(s), critical questions need to be raised. For example, to what extent do the externally-driven infrastructure policies and planning logics apply to and respond to different local social groups and their water needs? How does the perpetuation of the unequal (re)distribution of scarce commodity of water affect different socio-economic residents? Which typologies of water supply configurations arise from the struggle of access to, control over and redistribution of scarce water supply among different users? To answer these questions, it is important to consider the spatial variations in the city's landscape alongside the plural institutional setting and diverse actors across time and space. For example, up-market neighborhoods are surrounded by sprawling and inadequately serviced low-income settlements supporting a large fraction of the population. This side-by-side co-existence of heterogeneous settlements and socio-economic classes will be rather informative in understanding the political economy of water access and use within various neighbourhoods of the city discussed in subsequent empirical chapters.

3. LIVING IN THE INTERSTICES OF A NETWORKED CITY: ACTUALLY EXISTING WATER SUPPLY MODALITIES IN EASTLEIGH, NAIROBI

3.1 Overview

The gap between planning ideals and grounded realities of everyday urban life is steadily widening across rapidly transforming cities, such as Nairobi. Each single day, the gap is manifested in various forms such as rising poverty, inequality, informality, unchecked rapid urbanization and socio-spatial fragmentation of all sorts (Gandy 2008; Huchzermeyer and Karam 2006; Roy 2005; Shatkin 2007; Watson 2014). These manifestations have attracted a huge scholarly interest, as researchers re-examine the planning ideals informing urban development in much of the Global South (Watson 2009a; Roy 2009a; Robinson 2006; Parnell and Robinson 2012). A common consensus in the urban development literature is that the planning systems in many African countries and the larger global South are inadequate and inappropriate to tackle the urban challenges of the 21st Century (Watson 2016). Correspondingly, ongoing infrastructure debates on the 'modern infrastructural ideal' reveal the model's limited applicability in cities of the global South and partly the North (Coutard and Rutherford 2016; Graham and Marvin 2001; Egyedi and Mehos 2012). Instead of the ideal outcome of a fully integrated and functioning networked city (Graham and Marvin 2001), many cities display either a 'splintered infrastructure pattern' (Kooy and Bakker 2008; Coutard 2008), 'infrastructure archipelagos' (Bakker 2003), 'premium networked infrastructures' (Graham 2000; Coutard 2002), or 'shrinking infrastructures' (Moss 2008). These variegated infrastructure patterns, I suggest, can be explained by seeking a different way of seeing and thinking that is both within and outside the dominant representations (Harrison 2006; Robinson 2006).

The Chapter mobilizes the concept of 'conflict of rationalities' (Watson 2003; 2009a) in framing the existing mismatch between the 'modern infrastructural ideal' and everyday water practices in Eastleigh, Nairobi. The Chapter not only advances the argument of 'conflicting rationalities' as an epistemology of the urban reality in cities of the global South, more importantly it interrogates the interface between the planners' rationalities and grounded daily practices as exemplified in water infrastructure and service provision in Eastleigh. The two rationalities (the modernist ideal and everyday practices of water access) are in constant interaction with each other and are deeply embedded in daily urban practices. At the local level, different networks of social groups exercise control and power over water supply, besides the policing gaze of the state agencies responsible for water provision. It is this interface (of the centralized water system and daily water practices)

that, I argue, promises wider possibilities for expanding our scope of understanding the strengths and failures of the networked city ideal in cities such as Nairobi.

The Chapter draws on a detailed case study of water infrastructure and supply practices in Eastleigh, one of the rapidly transforming districts of Nairobi. Eastleigh provides a rather apt illustration for the mismatch between conventional planning models and the exigencies of contemporary urban development. The case illustrates water supply mechanisms that contrast sharply with the 'modern' vision of the state planners and the public utility company. Whereas the planning policies of the County Government of Nairobi[6] and the responsible water utility companies[7] envision a networked system of water infrastructure and governance, the practical realities in Eastleigh indicate a complex and imbricated water practices that further intertwine with the spatial development dynamics of the area.

The example of Eastleigh brings into play various interest groups with differing rationalities than those pursued by the public planning institutions. Through the case, the chapter examines the interplay between the networked water infrastructure and non-networked mechanisms of water supply while cross-examining the roles played by different actors in water supply in the area. Empirical data was collected through field work conducted between February and April 2016. Semi-structured interviews were conducted with officials of the County Government of Nairobi and the Nairobi City Water and Sewerage Company. In addition, I held focus group discussions with three youth groups running water vending businesses in the area. In-depth interviews with residents doing business and living in Eastleigh and a lengthy chat with the Secretary of Eastleigh Community and Residents Association (ECRA) offered insights in the everyday lived experience amid infrastructure service struggle in Eastleigh. Significant data was also collected through review of relevant spatial planning policies affecting Eastleigh and national newspaper articles.

3.2 Conflicting rationalities: modernism vs. grounded realities

Vanessa Watson attributes the gap between planning ideals and grounded realities to a 'conflict of rationalities'—that is, between the logic of development and spatial control based on 'modern' visions promoted by state agencies, private actors, consultants and urban planners, and the logic of survival by a

[6] The County Government of Nairobi is the state agency responsible for planning and public service provision in Nairobi.

[7] These include the Athi Water Service Board (asset owners and capital infrastructure investments); and the Nairobi Water and Sewerage Company (daily supply, repair and maintenance of water and sewerage networks).

highly differentiated, diverse, multicultural and situated urban citizenry (Watson 2003; 2009a). Cities embody diverse and fluid identities with varying livelihoods and multiple ways of space use that is increasingly (re)shaping spaces (Simone 2004). The contemporary city is characterized by deepening social and economic differences and multicultural complexities (Watson 2006). Yet within the socio-economic and political differences, planning activities are still being guided by a universal set of ideals promoted by dominant actors (Roy 2009a). The different world-views and value-systems are given insufficient attention by planning authorities (Miraftab 2009; Benjamin 2008). For instance, Harrison (2006) notes that the technical-rational thinking of planners undermine other logics of place-making by categorizing the latter as informal, illegal or even silenced. Yet the treating of the two rationalities as far-apart from each other has resulted in an increasing discrepancy between the everyday realities which defy planning philosophy and thought (Watson 2009a; Shatkin 2011)

It is evident that planning is characterized by conflicts, especially from daily practices within a pluralistic and multicultural urban society (Pløger 2004; Watson 2006). The techno-managerial and marketization systems of governing and service provision by public institutions is more often met with mixed reactions by different urban residents, particularly by the largely marginalized socio-income groups (Bakker 2010; Miraftab 2009). The everyday lived experience of ordinary people is regularly seen to be in conflict with official urban visions of achieving 'modernity' (Rigg 2007; Simone 2004). By way of espousing 'conflicting rationality', Watson (2003) searches for an interpretative and translative possibilities that lay in the interstice between different frameworks of rationality —what she terms the 'interface'. According to Watson (2009a), the interface is a zone of encounter and contestation between these various rationalities.

> It is that point at which state efforts at urban development and modernisation (provision of formal services, housing, tenure systems), urban administration or political control (tax and service fee collection, land use management, regulation of population health and education, e.t.c.) and market regulation and penetration, are met, or confronted, by their 'target populations' in various and complex ways, and these responses in turn shape the nature of interventions (Watson 2009a: 2270).

The clash of rationalities—the interface—has been labelled differently in academic literature. For instance, Holston (1998) and Miraftab (2009) refer to 'insurgent urbanism'. Other dominant nomenclatures that represent a contrast of a modernist planning ideals in one way or another include 'occupancy urbanism'

(Benjamin 2008), 'splintering urbanism' (Graham and Marvin 2001) and 'subaltern urbanism' (Roy 2011). These 'urbanisms', among others such as 'informal urbanism', reveal diversity of socio-spatial forms that planners encounter as they endeavor to 'reshape urban social, political, and cultural life and spatial relations to conform to an ideal of a [modernized] globalized, cosmopolitan, economically integrated, and competitive city (Shatkin 2011: 79). In what he collectively calls 'actually existing urbanisms', Shatkin (2011) argues that the different urbanisms are a manifestation of various appropriations of urban space that contravene modernist planning ideals. The existing urbanisms are rooted in alternative social dynamics and rationalities including but not limited to informality, contestations, alternative cultural and social visions and vote-bank politics (Benjamin 2008; Roy 2011). The acknowledgement of multiple modernities across cities in the global South is indicative of a differing logic and adaptation to modernism. The multiple modernities can be emancipatory instead of being viewed as inadequate copies, or distortions of development in the North (Harrison 2006). More importantly, existing urbanisms challenge the monolithic view of urban regimes, as well as the authority of modernistic planning visions (Shatkin 2011). In the place of westernized and modernistic ideals, a focus on subalternized knowledge (Roy 2011) may be helpful in charting a different way of thinking that re-engages with grounded realities.

The unpredictable encounter and contestation at the interface open up the possibility for exploring alternative approaches to planning (Watson 2009a). For our purposes, the interface can be seen as the point at which different forms of translation, adaptation, appropriation, hybridization and refusal of the 'modern infrastructure ideal' by different actors is manifested through day-to-day interactions with socio-technical systems of water service delivery. It should be noted that power within and outside the state plays a great role in shaping the interaction among actors that claim control over urban space (Watson 2009b; Shatkin 2011). The multiple interests and differing rationalities are dynamic, often opportunistic and inevitably shaped by power (Pløger 2004; Harrison 2006). To emphasize the role of power, 'gray spacing' (Yiftachel 2009) provides a useful conceptualization of how power can work to favour and disfavor different rationalities depending on their alignment. According to Yiftachel (2009), gray spaces are positioned between the 'whiteness' of legality/approval/safety, and the 'blackness' of eviction/destruction/death' (p. 88). Whereas much of the urban development process takes place within gray spaces, activities associated with the powerful in society tend to be whitened towards legality while all that comprises the bottom-ranked and the powerless in society tend to be blackened, criminalized and destroyed. Here, it is important to note that rationality is not static to a particular organization or community (Bridge 2005). Instead, actors traverse various spheres as long as it

works to their advantage (Miraftab 2004). The various spheres more often overlap, making it difficult to draw a sharp distinction between structure and agency, which are dissolved through intricate flows of power (Roy 2005; Roy 2009b).

There is therefore need to rethink the nature of planning and its relationship to power and institutions as contemporary cities are complex, dynamic and embody multiple interests and spatialities (Todes 2011). Such a perspective can enrich our understanding of new planning approaches that avoids ineffectiveness or a return to past modernist planning ideals (ibid.). Watson (2006) evokes a return to the moral ethics and value of 'deliberative and consensus-seeking' (Healey 2003; Innes and Booher 1999; 2003) in rethinking planning rationalities. The need to see planning as negotiating and mediating between conflicting rationalities is echoed by other scholars (Pløger 2004; Harrison 2006). Notably, consensus-seeking tasks in African cities and other parts of the global South has proved to be a difficult task. For instance, emphasis is laid on civil society in bringing democracy into consensus building yet in African context the civil society is itself often dysfunctional and internally fractured (Watson 2009a; Swyngedouw 2005). The underlying institutional environment in consensus-planning is thus wrought with multiplicity, diversity and dynamics of value systems, power relations and interplay of actors with specific interests shaped by social, economic and environmental forces (Innes 2004; Healey 2003; Albrechts 2012). The differential power structure among stakeholders undermine the democratic credibility of processes, especially where ordinary residents do not hold equal power as other key stakeholders influencing outcomes.

Sehring (2009) suggests the concept of 'institutional bricolage', which can offer an alternative path by recombining elements of existing rationalities. Institutional bricolage explains how local actors recombine elements of different institutional logics while changing their meanings to improve their well-being. In essence, formal institutions and informal institutions are dynamic and could learn from each other. In this Chapter, I focus on the interstices of the networked city, where the planning and rationality of the modern infrastructural ideal have intermingled and produced different models of water supply. This focus is relevant as it elucidates a counter-argument to the dominant perspectives of the networked city as promoted by policy decisions through a rationality of achieving a desired infrastructure system oriented towards an 'elsewhereness', instead of valorizing the situated survival tactics of the marginalized. A special consideration is given to zones of interaction between the networked water system and survival mechanisms of the locals. The example of Eastleigh as a dynamic space is now advanced in the sections that follow.

3.3 Spatial development and infrastructure provision in Eastleigh

Eastleigh is one of the oldest planned residential neighborhoods in Nairobi. Currently, Eastleigh is designated as a commercial district that is functionally related to the main Central Business District (CBD) of Nairobi (CCN 2008). The neighborhood is located approximately four Kilometres east of the CBD and covers an area of about 120 hectares (CCN 2008; GOK 2010). It is bounded by the Moi Air Base to the East, Juja Road to the North-West, Nairobi River to the South and New Pumwani Estate to the West.

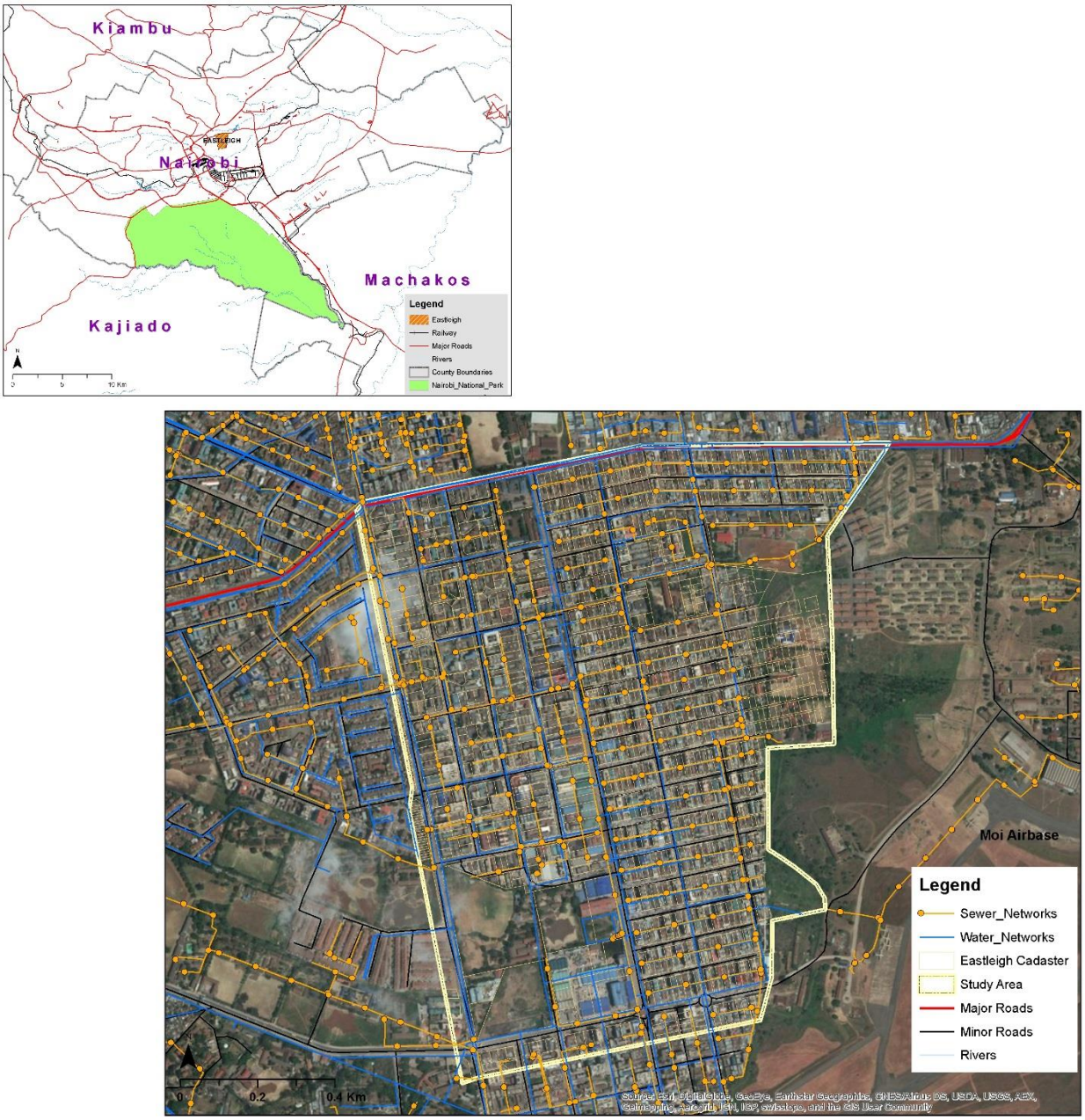

Figure 3-1: Location of Eastleigh within Nairobi

Eastleigh was founded by the British colonial government and gazetted as a township in 1921 (Murunga 2012). The township was planned for a population of about 37,000 residents (Asoka and Bunyasi 2013). Following the racial and functional planning principles of the colonial administration (K'Akumu and Olima 2007), Eastleigh became an Asian enclave, although it also housed elite Africans at the time, comprising clerks, builders and shoemakers. The segregated functional zoning of Eastleigh as a residential area was reinforced in the 1948 colonial master plan of Nairobi. Under this master plan, Eastleigh was laid out in a chessboard-like pattern, with a grid-iron street layout (figure 3-1). Wide avenues run in North-South direction and are intersected by East-West streets lined with trees. The housing typology was specified as low-density single-dwelling units with resemblance of Asian architecture (see figure 3-2 for remnants of old Asian houses). Infrastructure facilities and services such as drainage and water supply followed the street pattern and serviced each land parcel.

Figure 3-2: High-rise housing typology (left); a section of busy commercial area in Eastleigh

A steady increase in population into the city in the 1950s prompted the city administration to adopt a new policy. There was need to expand the commercial centre to accommodate the entrepreneurial activities of the incoming population. In response to this demand, a policy framework was instituted in 1959 that allowed light commercial activities in Eastleigh (CCN 2008). This policy was later reviewed and reinforced under Minute No. 9 of the City Council of Nairobi (CCN) in December 1968. In November 1984, the CCN reviewed this policy to cater for an enlarged catchment population of about 200,000 people by the year 2000. By this time, Eastleigh was already experiencing rapid growth in terms of population, commercial activities and housing developments. The 1984 policy thus recommended the creation of nucleated commercial centres as opposed to a linear-type development and increased building densities allowable in the area to higher ratios.

Accordingly, the plot ratio was raised from 0.75 to 1.5 while the ground coverage was changed from 0.35 to 0.6 (CCN 2008). The planning implication of these re-zoning guidelines was a rapid change of the single-dwelling housing topologies to four-floor commercial-cum-residential flats. Notably though, there were no proposals for infrastructure upgrade to accompany these new changes.

The role of Eastleigh as a commercial centre was re-emphasized in yet another policy adopted in May 1989 (CCN 2008). The 1989 policy plan was named the 'Eastleigh District Centre Strategy of 10th May, 1989 (ibid.). Under this new arrangement, Eastleigh was to serve as a secondary commercial district for the entire Eastlands of Nairobi. The centre was to accommodate low level commercial activities for a catchment population of about 432,000 people. The aim of the 1989 policy plan was to effect the provisions of the 1973 Nairobi Metropolitan Growth Strategy, which proposed decentralization and development of alternative service centres within selected districts of Nairobi. As such, each district was to be served by one centre that would help reduce high employment density in the CBD. Each district centre would have new housing, one or more industrial area and a commercial centre. It is within this framework that the Eastleigh District Commercial Centre (EDCC) was created. Under the accompanying infrastructure plan, only the road networks seemed to have been given attention as there were recommendations for building setbacks and road widening. The plan was silent on other basic infrastructure services such as water and sewerage.

In 2008, the City Council of Nairobi prepared a Local Physical Development Plan (LPDP) for Eastleigh. The aim of the LPDP was to review the planning policies of Eastleigh for a sustainable urban development in Nairobi. Similar to previous policies, the LPDP focused on density specifications in terms of building setbacks, plot ratios and ground coverage. These guidelines further increased the development density of Eastleigh to reflect its re-emphasized status as a district centre. The plan was to cover a period of up to 2024. It was also projected to cater for a resident population of 394,272 by the horizon year (CNN 2008). The plan acknowledged the then deplorable infrastructure condition that was manifested in congested roads, poor drainage, sewer bursts and poor garbage collection. To date, the LPDP remains the official planning policy that provides the framework for urban development and infrastructure development in Eastleigh. In addition to the LPDP, the County Government of Nairobi uses the provisions of the Nairobi zoning ordinance of 2004 to control and approve new development applications by developers.

3.3.1 The missing point: implications of the previous spatial policies

Despite the various population projections envisaged under the spatial plans and policies outlined above, the influx of people into Eastleigh always surpassed the official estimation. More importantly, the population projection of the area did not take into account unforeseen socio-political forces that have greatly influenced migrant numbers. Of importance to Eastleigh is the socio-economic instabilities in North Eastern Kenya and political conflict in neighboring Somalia that have hugely affected Eastleigh's demography. In the early 1980s, North Eastern Kenya was hit by a severe famine forcing the Kenyan-Somali natives to give up livestock, which was their main source of livelihood. Around the same period (between 1970s and 1980s), Somali immigrants were already fleeing Siyaad Barre's regime in Somalia (Abdulsamed 2011). In 1991, the Somali state collapsed and approximately 300,000 refugees sought safety in Kenya (Abdulsamed 2011). Since Eastleigh was home to a few Kenyan-Somali who either served as colonial employees or independent traders (Lindley 2007), majority of the Somali refugees and famine survivors filtered into the Eastleigh neighborhood. This development has over time transformed Eastleigh into a centre for Somali entrepreneurship, earning the area its popular name of 'little Mogadishu'. The influx of Somalis into the area has precipitated a changing demographic composition that is hardly reflected in official planning statistics. Combined with city-wide urbanization pressures, rural-urban migration and natural growth, Eastleigh demographics today presents a huge pressure on the capacity of the water networks.

To compound the problem, the past spatial planning and zoning policies proposed higher building densities and change of functional use of Eastleigh from purely single dwelling units to incorporate high-rise commercial development. The commercial interest has overridden residential functions over time, with new buildings in the area going up to eight floors. The problem is compounded by minimal enforcement of the development control guidelines. Building construction is driven chiefly by private business interests controlled by immigrant Somalis. This has had impacts on both spatial and socio-economic transformation of Eastleigh against the backdrop of limited municipal service provision. The Somali refugees particularly buy-off old residential blocks and rapidly convert them into modern shopping malls and complexes. The Somali influence in Eastleigh is so much that there has emerged a strong network of trade in Eastleigh that connects the Arabian Peninsula, Somalia, Kenya and East and Central Africa (Abdulsamed 2011), opening it to the global market. Property acquisition and development thrives on financing from the wider Somali diaspora that fuels intensive commercial and business oriented developments in Eastleigh. Sadly, the rapid spatial

transformation continues to take place in the absence of any infrastructure upgrade to match the new status of Eastleigh as a commercial zone.

Fundamentally, the previous spatial development frameworks had no or little linkage with specific infrastructure development and demand. Moreover, the spatial plans are not accompanied by budget allocations to facilitate implementation of proposed projects. Consequently, there is a huge gap between water demand and water supply, not only in Eastleigh but in the entire Nairobi. The strategic location of Eastleigh, with ease of access to the CBD, seems to have enhanced its potential for trade and thus attracted commercial uses that were not originally planned for the area. The ensuing developments have exerted enormous pressure on the existing water supply system. The picture is similar when it comes to other infrastructure systems. For instance, in the recordings of parliamentary debates of 9 October 2008, a parliamentarian questioned the then Minister for Local Government on when he would authorize the rehabilitation of the sewerage system to cater for the current population and not that of the 1950s. The Minister's response stressed the government's lack of funds, which provides an insight into why Eastleigh, and the larger Nairobi still relies on old colonial water infrastructure. The local government and public utility companies often cite lack of adequate resources to expand the water networks in tandem with urban development. As a result, most of the infrastructural plans for Eastleigh, particularly the 2008 LPDP, have not been implemented (JICA 2014). To echo the problem of poor plan implementation, the Assistant Director of Planning at the Nairobi County Government was quoted in the local media remarking that 'Eastleigh should not have all these problems. The City Council Planning Department has always had master plans for the area as far back as the 1980s. But they either take too long to implement or are never implemented'.[8]

3.4 Water supply in Eastleigh: a juxtaposition of modernist planning rationalities and actually existing modernisms

The narrative in Section 3.3 provides a broad basis for a detailed discussion centred on the water supply mechanisms in Eastleigh. As can be inferred, the water infrastructure serving Eastleigh dates back to the colonial period. The water reticulation system was built between the late 1940s to early 1950s (Asoka and Bunyasi 2013). The pipe networks had specified capacities, namely 14-inch main pipes, four-inch distributor lines, and two-inch service lines (ibid.). The then network's capacity was calculated based on the housing typology, as well as the existing population at the time. However as already narrated, the population of

[8] http://www.nation.co.ke/news/1056-507538-k91e8mz/index.html accessed on 3/01/2017

Eastleigh kept rising rather sharply over time and space. While the water infrastructure was initially designed to serve 37,000 people (Asoka and Bunyasi 2013), the latest national census report indicates there are 315, 496 people living in Eastleigh (GOK 2010). The Somali population alone is estimated at between 100,000 to 200,000 persons (CCN 2008). Considering that this census population figure was done in 2009, the projected population as outlined in the LPDD of 2008 have been surpassed. There is obviously a stark mismatch between water supply and demand in Eastleigh. As a result, various water supply modalities have mushroomed over time to bridge the growing deficit. These modalities form the focus of discussion in this section.

To begin with, the Nairobi City Water and Sewerage Company (NCWSC) is the public utility responsible for water supply in Eastleigh and the entire Nairobi region. The utility company operates a centralized water system, whereby all its customers are connected to the centralized water network and pay monthly bills based on meter readings. According to the official plans, Eastleigh is totally covered by the NCWSC's network. This network is based on the colonial grid pattern that delivered water to each parcel. Considering the socio-spatial transformation that is currently underway in Eastleigh, the NCWSC is forced to regulate water supply into the area through a rationing programme that only sees Eastleigh supplied with water on some days of the week. It should be noted here that water rationing is a major strategy that the NCWSC employs to deal with the overwhelming city-wide water demand, which today stands at 580,000M^3 against supply capacity of 465,000M^3 per day (Asoka and Bunyasi 2013). However, the water rationing affects different parts of the city in varied ways, depending on the socio-economic class of residents. Eastleigh falls under the Eastern region of the service blocks of the NCWSC. Unlike other water corridors and regions that have regular water supply (e.g. the Western region and the CBD), the NCWSC only pumps water into the Eastern corridor twice a week. This means that residents of Eastleigh receive water two days in a week, mostly on Saturdays and Sundays, although this too is not guaranteed as the service days keep shifting. To their credit, the NCWSC notifies residents of their rationing programme to prepare residents to fill up their containers. Nevertheless, with or without the company's notice, residents always keep on standby water storage tanks for any water eventuality, as the rationing programme has become normalized in their everyday life.

Increasingly, pumping machines have become a crucial technical component of the water infrastructure in Eastleigh area (figure 3-3). This is in response to the problem of low water pressure, particularly in high-rise buildings. As observed earlier, the water problem in Eastleigh is compounded by higher building densities

against the backdrop of low technical and volumetric capacity of the old water supply system. Accordingly, even on days that the NCWSC feeds water into the Eastern corridor, Eastleigh residents are not guaranteed of actual water supply. Interviews with residents living and doing business in Eastleigh revealed a combination of low water pressure and rationing, with residents lamenting that the level of service is woefully inadequate. Those who occupy higher storeys of buildings are more affected as the low pressure cannot allow water to reach higher floor levels. Electricity-powered water pumps are therefore fitted at the ground level to facilitate water delivery, especially to higher-level floors. According to field interviews, water pumping costs constitutes a huge part of monthly household expenditures. Moreover, as the electricity supply is also not stable due to regular interruptions (power blackouts), property developers are sometimes forced to use diesel pumps. The use of these machines has immediate implications for residents who must shoulder the extra cost in inflated house rents. Where there are no booster pumps, residents are forced to fetch water on the ground floor and carry the precious commodity through long and dark staircases to their units. That daily exercise requires manly labour, a fact that disrupts the gendered household roles, in which water fetching has traditionally been the female's province. Field findings revealed that it is the women who are traditionally tasked with securing water supply for their households. Even where they are unable to carry water four or five stairs to their dwellings, women still have to endure lengthy time waiting on the queue for their turn to fill their containers. They still must pay other men to carry the containers to their houses, once they are filled. As one respondent narrated, 'Every Saturday I have to rise up very early in the morning regardless of whether I am going to work or not. I climb down the stairs to join the queue at the tap before it either gets too long, or the water disappears. This has become my life's routine'.

The water problem significantly affects the renting pattern and occupancy of the high-rise buildings in Eastleigh, which have largely been left to the Somali immigrants. The fact that majority of occupants are Somalis who are largely Muslims, water services in the area has a socio-cultural meaning. For instance, their day-to-day practices such as human waste disposal demand waterborne facilities. The local demand for water therefore has spawned a multiplicity of water supply alternatives in the area.

Figure 3-3: Pressure pumping machines to extract water from NCWSC's mains to storage tanks in Eastleigh

Yet another critical mode of survival in the interstices of water shortage is the must-have water storage containers. Every building is fitted with both underground and overhead water storage tanks that help residents survive service outages. The cost of fitting these storage tanks is borne by the property developer. Besides, each household has invested in domestic water storage tanks stationed within their premises to help iron out irregularities in the water supply schedule. While containers are not usually featured in the conventional water infrastructure, they serve an important role in evening out the kinks in the water supply regime. In general, the water supply system in Eastleigh is characterized by uncertainty and anticipation as exemplified by the daily struggles of residents struggling to save as much water as they can, not knowing when next to expect water at their taps. The household reservoir containers range from 20-litre jerry-cans to 100,000-litre water tanks. As can be expected, the use of water storage facilities has broader socio-economic implications for the households and businesses in the area. Of immediate concern is the high likelihood of water contamination during fetching of water in smaller quantities for domestic use that involves dipping of containers directly in and out of the storage tanks. Residents reported instances where some of the storage tanks are not properly covered, leaving room for dirt intrusion. There were even field reports of pets drowning in large water containers unnoticed, while members of unsuspecting households continued to consume the water oblivious of the dangers involved. Ordinarily, the storage tanks require regular cleaning and maintenance, a practice that is hard to come by. This means that residents have to treat the water once more before drinking. Majority of the households preferred boiling water specifically meant for drinking, a practice that entails incurring additional fuel costs. Moreover, the storage tanks have shaped space organization

within and without buildings, sometimes creating congestion at the household levels as any left-over space including balconies are occupied by water storage containers.

Despite the challenges at the household level, the water shortage in Eastleigh has created an opportunity for water businesses to thrive in the area. The business attracts various actors, from large-scale entrepreneurs who operate water trucks, to hand-cart pullers and kiosk operators. Upon alighting from *Matatu*s (passenger buses) plying the Eastleigh route, one is confronted with the sight of water bowsers streaming into Eastleigh's main shopping district to deliver water. The large commercial enterprises mostly rely on the water trucks for their daily supply. The water trucks source their water from other parts of the city with good connections to the NCWSC's water supply network. The operators obtain official license from the County Government, in the form of single-business permits to supply water. Alternatively, they register private companies under the Companies Act. Meanwhile, cart-pullers and water selling kiosks dot the streets of Eastleigh, catering to the majority of households in the area. Throughout the neighborhood, 20-litre jerry-cans for water retailing are readily displayed in front of shops (see figure 3-4). Having noticed the pathetic water situation, various youth groups are now involved in the sale of water, either by running water kiosks, public toilets, or car washing services in Eastleigh.

Figure 3-4: Water vending activities on the streets of Eastleigh

The resultant water business in Eastleigh is therefore a complex web of water supply mechanisms comprising the NCWSC, youth groups and individual water enterprises, all in the business of delivering water to Eastleigh residents. The water supply modalities are all enmeshed and interconnected to ensure every actor remains

in the business. A prominent feature of the water supply system is the difficulty of drawing the line between the authorized and unauthorized water suppliers. For example, although it is common for water vendors to hijack pipes with flowing water and directly connect, illegally, to the main distributor lines, they still claim having obtained operating license from the NCWSC. Furthermore, some youth groups operating kiosks acknowledged receiving support from the local area administration through donations of water tanks to enhance their water storage capacity. Such material support by political actors gives legitimacy to what would otherwise not qualify as legal business. Yet the clandestine connections are a health risk as they threaten the quality of water supplied in the neighbourhood. On another note, the pricing of water services by vendors is largely left to the forces of the market. The cost of water in Eastleigh therefore varies from time-to-time, depending on water availability. As such, residents find themselves paying the regular monthly water bill to the NCWSC while still incurring additional costs of augmenting water supply through the various strategies outline above. Having to pay for water from different suppliers has an impact on household income and expenditure. Residents complained of spending more money on water than they had budgeted for, because of ever-changing water prices. For example, while a 20-litre jerry-can sometimes retail at KSH 5, it is at times sold at between KSH 20 – 30. Here, the role of the national regulator of water services, the Water Services and Regulatory Board (WASREB) comes into the picture. Although WASREB sets water tariffs for all regions across the country, the enforcement of its regulations is not manifested in the day-to-day water selling activities as exemplified by the lucrative business of water vendors in Eastleigh.

Another water supply modality in the area is the sinking of boreholes. Left with no choice, a majority of property developers sink private boreholes to augment the NCWSC's water supply. From field interviews, the use of ground water has become a mandatory alternative for new developers of high-rise buildings in the area. However, many of these boreholes are sunk at very close proximities to each other, yet each developer claims to have obtained official permits to do so from the regulatory authorities. Underground water is regulated by the Water Resource Management Authority, which is supposed to monitor extraction to ensure sustainability of water aquifers. However, the official regulations as pertains to borehole drilling are in contrast with happenings on the ground as sinking of boreholes for ground water abstraction proceeds without discernible regulatory enforcements.

The poor water situation has not only brought about alternative supply modalities, it has also triggered grassroots agency to push for improvement of water services in Eastleigh. A case in point is the Eastleigh

Business District Association (EBDA), which promotes the commercial interests of the Eastleigh business community, that is, from small street vendors to the large shopping complexes.[9] The organization is however heavily influenced by skewed power structures in favour of the Somali businessmen, the majority of whom own the shopping malls in the area. Lately, members of EBDA have been at the forefront seeking audience with the County Government of Nairobi to voice their complaints.[10] The EBDA have observed the stark contrast between the amounts of tax revenue the government collects from their businesses and the poor state of infrastructure in Eastleigh. It is estimated that Eastleigh accounts for one-third of Nairobi's economy and some 25 percent of the total tax revenues collected by the city council.[11] In September 2016, the EBDA led weekly protests marked by closing down of all shops, for what they termed as 'unconducive business environment'. The Chairman of the association affirmed that 'by closing down the shops, it means we will not pay KRA [Kenya Revenue Authority], rent and other levies to the area government [City County] and this will have an impact on the country's economy'.[12] This is not the first time Eastleigh business operators have taken action against unresponsive state agencies; in June 2010, the traders successfully petitioned the high court to bar the Nairobi City Council from collecting taxes from over 3000 traders operating in Eastleigh for not offering municipal services in return.

In response to grievances of the residents of Eastleigh, the city authority has been commissioning piece-meal infrastructure projects to improve various infrastructure services. In regards to water supply, a youth mobilisation dubbed 'Kazi Kwa Vijana' initiative was contracted in 2010 to lay new water pipes along Eastleigh's First Avenue. However, the small-scale nature of the project meant that no significant improvement was felt across the neighbourhood. Instead, the move was seen as a way of quelling the residents' complaints that were growing louder at the time. It becomes apparent that the water situation is not about to change any time soon unless the public utility companies obtain the required resource capacity to overhaul its entire water infrastructure system for the entire Nairobi region.

[9] http://www.hiiraan.com/news2/2011/mar/nairobi_city_council_to_invest_sh5_bn_in_eastleigh_infrastructure.aspx accessed on 29/12/2016

[10] https://www.standardmedia.co.ke/article/2000214175/eastleigh-shops-closed-in-weekly-protest accessed on 29/12/2016

[11] http://www.businessdailyafrica.com/-/539546/1032282/-/view/printVersion/-/yc3vfm/-/index.html accessed on 29/12/2016

[12] https://www.standardmedia.co.ke/article/2000214175/eastleigh-shops-closed-in-weekly-protest accessed on 29/12/2016

3.5 Conclusion

The foregoing discussion has been an attempt to unravel the actually existing modernity through a closer examination of water supply modalities in Eastleigh. As the case demonstrates, it is within the interface between the planners' rationality and the everyday practices that urbanizing societies develop social spaces in which hybridity is cultivated through a mix of (often exclusionary) state policies and (sometimes liberating) popular practices. As a result, unconventional water practices such as water rationing by the utility company, use of booster pumps and water containers have increasingly emerged at the interstices of a previously envisioned networked city. These modalities have significantly influenced the institutional and governance approach and practices of the public utility. The NCWSC for example is forced to regulate its water flow by manipulating water flows in its various water corridors. This has in turn heavily impacted the lived experience of Eastleigh residents who on their part mobilize various ways of coping with the water shortage.

The deteriorating infrastructure services in Eastleigh has borne a complex mesh of a water landscape with various actors, interests, values, culture and political economy that is diverse, taking into account changing demographics and land development patterns. These grounded realities negate the underlying assumption of the modern infrastructure ideal, which sees urban space as a homogenous terrain while assuming that urban planning will effectively regulate land use to guarantee uniform provision of critical services across the city. As observed, the spatial planning policies governing development in Eastleigh have reshaped existing and emerging infrastructure patterns in contrast to official water policies. While spatial planning is supposedly intricately linked with infrastructure development, this is not often followed by planning authorities, let alone implemented. What we see is a lack of coordination among different state agency involved in planning and provision of infrastructure services. Particularly, the City planning authority and the public utility need to link their policies during plan-making and implementation processes.

The Eastleigh case presents a dynamic illustration of how modernistic planning rationales may fail to deliver basic services in different socio-economic contexts. The infrastructural and planning ideals fail to anticipate changing socio-political patterns that continue to shape how the state planning authorities, public utilities, the private sector, and moreso ordinary people receive and respond to official policies. In the upshot, spatial plans which are supposed to control development and ensure sufficient delivery of basic services miss the dynamics of rapidly growing cities; population projections become static and out of date, rendering most planning proposals unrealistic. The result is a bulging population that easily overwhelms the existing

infrastructure systems. The population in turn gets marginalized in service provision. The mismatch between modernist ideals (master plans and infrastructural ideals) and grounded realities explain the variegated water landscape across Nairobi. A renewed analysis of the changing relations between spatial planning, city development and infrastructures can thus arguably inform better planning practice. Meanwhile, the kind of reengagement I propose here could unravel more about living in the interstices of rapidly urbanizing urban landscape as well as potentially ease the infrastructure service inequality in rapidly transforming cities of the global South.

4. ENCLAVE INFRASTRUCTURES: THE PARADOX OF WATER INFRASTRUCTURE AND SERVICE PROVISION IN RUNDA, NAIROBI

4.1 Overview

The literature on urban Africa has predominantly focused on informal settlements, broken infrastructures, inadequate management practices and poor service delivery in what Martin Murray collectively terms as 'failed urbanism' (2015b; 2016). However, such focus has blurred the expanding heterogeneity of urban landscapes across the rapidly urbanizing cities in Africa. More importantly, the focus on failed urbanism misses to imbricate the growing informal settlements phenomenon with increasing creation of new satellite cities and residential gated communities that is shaping the contemporary urban landscape in varied ways (Murray 2016; Harris 2015; Watson 2014). All together, these different urban forms are part of a singular intertwined process of spatial transformation in these cities (Murray 2015b).

Cities in Africa are experiencing a growing spatial unevenness brought about by development of new affluent enclaves side by side with informally developing settlements (Watson 2014). Private property developers are quickly changing the socio-spatial configuration of current cities by developing enclave spaces that explicitly serve the interests of large-scale transnational corporate investors, local business coalitions and local socioeconomic and political elites (Murray 2016). The enclaves form a basis for affluent consumers of high quality and world-class services and infrastructure (Murray 2016; Graham and Marvin 2001). Notably, these new developments by-pass the current city messiness such as broken infrastructures and inadequate enforcements of land use regulations (Murray 2015b). Instead, private property speculators invest in new infrastructure networks for their rich clientele either in partnership with public utilities or on their own initiative (ibid.). Although there is a growing research attention towards the newly developing urban enclaves, little research has been done to understand the production and functioning of infrastructure systems within such enclave spaces. It is this task that is taken up in this Chapter.

The increasing physical and socioeconomic fragmentation of the urban space, and by extension the 'modern infrastructure ideal' have contributed to the rise of enclave infrastructure systems in contemporary post-colonial cities, such as Nairobi. The uneven emergence of enclave networked infrastructure spaces reproblematize and undermine the principles of a 'modern infrastructural ideal' (Graham and Marvin 2001). In place of a unitary, orderly, integrated and ubiquitously networked city, infrastructure systems are being

'unbundled' and 'splintered' in various forms (Graham and Marvin 2001; Coutard 2008; Kooy and Bakker 2008). For example, completely new private infrastructures are constructed from scratch to serve emerging urban enclaves (Herbert and Murray 2015) while in some cases, new user demands cause socio-technical reconfiguration of old networks to suit specified needs (Graham 2000). According to Graham (2000), enclave urban spaces may constitute 'premium networked spaces'. He defines premium networked spaces as new or retrofitted networks of transport, telecommunications, power, or water and sewerage infrastructures that are customized precisely to the needs of powerful users and spaces, whilst bypassing less powerful users and spaces (p.185). Graham further notes that there is not much studies that analyze the diverse ways in which enclave networked spaces are constructed, legitimized and maintained—politically, socio-technically, legally and geographically (see also Coutard 2002).

The widespread emergence of enclave infrastructure systems has been observed in rapidly urbanizing cities across Africa (Watson 2014; Murray 2015; Herbert and Murray 2015). This trend is closely related to the urban phenomenon of 'enclave urbanism' (Atkinson and Blandy 2005; Douglass, Wissink, and van Kempen 2012; Wissink et al. 2012) that has shaped a recent wave of real estate development across the continent. Enclave urbanism is explained by the spatial imprint of mosaics of homogenous urban forms that consist of specialized areas with distinct cultural, social, spatial, functional and economic users and activities (Douglass, Wissink, and van Kempen 2012; Wissink et al. 2012). Such spaces are manifested in the form of new satellite cities, foreign investments enclaves, business improvement districts, commercial malls, theme parks and residential gated communities (Graham 2000; Graham and Marvin 2001). This chapter focuses on residential gated communities as one of the dominant form of enclave urbanism with a strong emphasis on infrastructure provision within such spaces.

Gated communities are walled or fenced housing developments to which public access is restricted. They are characterized by legal agreements which tie residents to a common code of conduct and often collective responsibility for management (Atkinson and Blandy 2005). The 'discourse of fear' (Blakely and Snyder 1997) has been used to explain early forms of gated communities particularly in the contexts of Latin America and South Africa (Cséfalvay and Webster 2012). However, authors like Low (2001) argue that fear is only used to justify social and physical exclusions of gated communities. Cséfalvay and Webster (2012) add that the withdrawal of the rich; flight from blight by a gating coalition of developers, local governments and middle-class homeowners; and neoliberalization of service sectors advocating for private as opposed to public

provision of services and goods contribute to ascent of enclave communities. Moreover, a desire for status, privacy and real estate investment potential of gated housing drive their construction (Atkinson and Blandy 2005; Blandy 2006; Wu 2010; Wissink et al. 2012). Notwithstanding, it is widely accepted that gated communities emerge in various forms, for different reasons in different places and it is in no way uniform in its characteristics or development trajectory (Le Goix and Webster 2008; Yip 2012; Wu 2010; Douglass, Wissink, and van Kempen 2012; Wissink et al. 2012). It is for this reason that Cséfalvay and Webster (2012) argue for more precise and contextualized empirical research in explaining the gating phenomenon.

The large volume of literature on gated communities however, is more shaped by gating phenomenon in cities of the Global North. The 'fortified enclaves' (Blakely and Snyder 1999) have continued to dominate literature on gated communities. Notably, gated community debates have scarcely engaged the African context (Landman 2004) with exception of South Africa whose variation of gated community, 'security-parks' receiving somewhat little research attention (Hook and Vrdoljak 2002). This Chapter therefore not only draws our focus to gated communities in 'ordinary cities' (Robinson 2006) such as Nairobi but also delves into analyzing the infrastructure arrangements in such residential enclaves. Although there have been attempts to theorize infrastructure in such spaces as 'premium networked infrastructure' (Graham 2000), the concept has remained under-explored in Global South contexts. There is little research on the socio-technical arrangement of these enclave spaces particularly from sub-Saharan Africa. Yet, cities in Africa have recently been featured as the 'new frontier' of enclave urban development and mega-infrastructure projects (Murray 2016; Watson 2014). The focus here is therefore timely and forms a critical contribution to the current and future urban infrastructure debates in Africa.

More specifically, the Chapter examines the intertwining of urban development processes of residential enclaves or 'gating', on the one hand, and construction of enclave infrastructure systems, on the other. In detail, the Chapter analyses the local nuances surrounding the production and governance of a networked water infrastructure system in Runda, an affluent contemporary residential enclave in Nairobi. Through the case of Runda, the Chapter aims to provide an understanding of how residential enclaves and their infrastructure systems are constructed, legitimized and contested over space and time. In doing so, the Chapter interrogates the interplay between private governance by the Runda Residents Association (RRA) and that of the County Government of Nairobi, while unravelling the complex and diverse processes of governance that support and resist the notion of a gated or enclave infrastructure systems. The analysis

makes a critical contribution to the understanding of the role of socioeconomic class in producing the urban socio-technical system of water provision in the larger Nairobi metropolis.

Empirical material draw from three fieldwork visits carried out in April 2015, February–April 2016 and November 2016. Semi-structured interviews were conducted with the Technical Manager of the Runda Water Limited (RWL), with permission of the Managing Director, during the field visit in April 2015. Moreover, five semi-structured interviews were carried out during the second fieldwork. This included interviews with the General Secretary of the Runda Residents Association (RRA) and four government officials each drawn from the Nairobi City Water and Sewerage Company (NCWSC), Athi Water Service Board, Water Service Regulatory Board and the County Government of Nairobi. In November 2016, in-depth interviews were carried out with a four-member committee of the RRA, who also served as long-term residents of Runda (over twenty years of living in Runda). Data collected covered the historical development of the Runda neighbourhood, Runda Residents Association and Runda Water Limited. Information was also sought on the operational activities and governance structures of Runda Water Limited and Runda Residents Association. The interviews also sought insights into the existential cohesion amongst Runda residents on the one hand, and the relationship between the residents and the County Government and the NCWSC, on the other hand. Project documents such as the Runda Water Strategic Plan, technical drawings (water distribution map and site layout plan of the water treatment plant), annual newsletters and Residents Association's development by-laws constitute the secondary material analyzed in this study. Grey literature from local newspapers and relevant websites provided additional data that greatly enriches the discussion.

4.2 Enclave urbanism: theoretical perspectives on production of enclave infrastructure systems

Lately, cities across Africa have witnessed ascent of enclave urbanism at the scale of new satellite cities, usually at the periphery of an existing major city. The evolving pattern of spatial restructuring has been associated with a distinctively polynucleated and fragmented city forms labelled by different urban theorists as 'enclave urbanism', 'private urbanism' and 'postmodern urbanism' (Murray 2015b). The new city enclaves are driven by international and local elite speculators redirecting capital into real estate development (Wu 2010). This newly emerging form of 'speculative urbanism' (Watson 2014) restructures cities into patchworks of secluded enclaves, each requiring new infrastructure connections. To serve the demands of their clientele, these new developments are increasingly planned and constructed as premium networked spaces, complete with isolated infrastructure (sub-)systems. Either, networked infrastructures are being reconfigured by

operators, property developers and users (Graham and Marvin 2001; Graham 2000) or totally new decentralized infrastructure systems are being developed to serve the urban enclaves. Whatever form the new infrastructure takes, the underlying principle is to transcend the perceived limitations of the standardized and monopolistic networked infrastructure model. As a result, customized and unbundled urban infrastructure networks are increasingly being designed for users in the socio-economic enclaves under closed infrastructure (sub-)systems.

The proliferation of enclave urban forms such as gated communities exemplify a new emergence of 'privatized planning' (Murray 2015; Shatkin 2011). By privatization of urban and regional planning, Shatkin refers to the 'ascendance of private-sector actors from a historically fragmented and indirect role in shaping urban form to a central role in the core functions of urban planning—the visioning of urban futures, and the translation of these visions into planning, development, and regulation of urban spaces and the network infrastructures that connect them on urban and regional scale' (Shatkin 2011: 78). This is true of current wave of real estate development in cities across Africa, whereby local and transnational consultants, corporates and private property developers have lately taken up planning role in executing new large-scale urban projects (Murray 2015). Be it through public-private partnerships or in singular, the private actors have assumed powers of spatial management. The newly acquired power allows them to establish their own legally accepted rules and regulations. Such rules act to exclude 'unwanted groups' while protecting the entrepreneurial interests of property developers to earn maximum returns from their premium developments (Murray 2016).

The privatization process can partly be explained by prevailing political economy and socio-technical processes underway in these cities. First, is the shifting role of the state to a more entrepreneurial role in facilitating private sector involvement in providing what was previously public infrastructure and services (Graham and Marvin 2001). Second, is the erosion of comprehensive urban planning and the construction of new consumptive spaces, which support infrastructural consumerism (Graham 2000; Coutard 2002). In place of comprehensive urban planning, urban landscapes are planned in separate enclaves cut off from the rest of the urban area (Murray 2004). Such enclaves emerge from the spatial dynamics of urban landscape as a contested terrain involving power and control of urban space where the question of citizen entitlements and 'who belongs' matters (Holston and Appadurai 2003). To service the enclaves, local authorities and public utilities are forced to depart from the 'modernist infrastructural ideal' that is argued to foster integration,

homogeneity and universality of the urban landscape. The isolated urban forms contribute to an increasing shift from standardized and territorially integrated infrastructure models to those that are more fragmented and spatially differentiated (Graham and Marvin 2001; Graham 2000). While often projected as the new face of development (Manji 2016; Watson 2013), this pattern of urban development exacerbates infrastructure disparity as nearby areas are by-passed by water, sewerage, electricity and road networks designed for the benefit of the 'new city' and its elite inhabitants.

4.3 Residential gated communities as typology of enclave infrastructure system

Gated communities have been on the rise across cities of the Global South. A changing institutional landscape that facilitates housing markets and land investments alongside increasing household incomes amid sharp inequalities have driven up gated communities (Harris 2014). The neoliberal market-driven economy concerned with transforming rapidly urbanizing centres into 'world-class cities' to act as trans-national capital and business hubs has promoted segregation of urban population into an elite class living in secluded neighborhoods from the majority poor (Sharma 2010). This 'enclave urbanism' has given rise to new urban forms consisting of enclosed city neighborhoods to which public access is controlled by gates and/or traffic barriers erected across existing roads (figure 4-1). The designated entrances/exits are manned by security guards on top of which are numerous installed CCTV surveillance camera as shown in Figure 4-1. Provision of privatized lifestyle facilities is also a common feature of gated communities (Douglass, Wissink, and van Kempen 2012; Wissink et al. 2012; Wu 2010).

Figure 4-1: Traffic barriers and CCTV cameras within Runda

The provision of infrastructure and community services within gated communities is often through privatized mechanisms of control, governance and management (McKenzie 2006; Le Goix and Webster 2008). It is assumed that the particularities and differentiated residents' demands make it difficult for a standardized service provision often necessitating customized arrangements to satisfy their (often exclusive) demands. The concepts of 'club realm of consumption' (Webster 2002) and 'private governance' (McKenzie 2003; 2005) have been used to provide useful explanation for the premium networks delivering services to residents of gated communities. Webster (2002) draws from institutional economics' 'club goods theory' to explain how gated communities, together with their members, constitute collective consumptive clubs. Be it a lifestyle, prestige or security zone community (Blakely and Snyder 1997), gated communities present a club realm of common interests (Wu 2010). The gating thus enables efficient provision of differentiated infrastructure services for targeted consumers in a single spatial location (Webster 2002). An important aspect is that residents are willing to pay a price for the efficient delivery of services, where quantity and quality are assured. Consequently, residents are explicitly assigned property rights over public goods within their neighbourhood, drastically reducing the risk of degradation.

The provision of services through a 'club realm' implies a form of private governance. Gated communities function as privately governed neighborhoods (McKenzie 2003). The private governance regime significantly reconfigures conventional modes of urban governance and public service provision. The housing development together with accompanying infrastructure create a private socio-spatial construct that isolates itself from the neighboring developments and the larger political system. Such development enjoys substantial economic resources from their well-off inhabitants who are also connected to an expansive network of urban professionals. Common to gated communities is a self-governing body usually made of property owners, home owners or resident associations who are tied to a common set of interests (McKenzie 2003; Le Goix and Webster 2008). The associations mostly act as proxies for city officials and reflect a deterritorialized power, whereby local authority's rules and regulations are substituted with community by-laws. Residents elect board members to oversee properties and establish covenants, conditions and restrictions to regulate activities within the community. The elected board establishes legal and organizational structures that define the mode of governance (see figure 4-3). Alternatively, residents may enlist the services of a private real estate management company (Chen and Webster 2005). The community association or enlisted professional company functions as a private government (McKenzie 2006). They are in charge of enforcing local development rules, maintaining property (e.g. street lighting, road pavements and

landscaping), and provision of infrastructure formerly provided by local authorities (e.g. water, sewerage and garbage collection). They also collect monies from residents and assess properties for maintenance and repair.

The various forms of private governance however, contribute to the fragmentation of urban infrastructure into micro-territories (Le Goix and Webster 2008). Worth noting is the fact that private governance mechanisms reveal underlying power imbalances. Particularly, the development outcome is influenced by power relations between real estate developers, public utilities, property buyers, potential residents and the state (McKenzie 2003; Glasze 2005; McKenzie 1998). Multiple interests from different actors in the development process imply that those with economic and political 'muscle' benefit more in terms of making decisions. In addition, unclear institutional mechanisms in dealing with various modes of private governance of club communities limit residents' and community associations' power in the wake of governance ambiguities. Problems of collective action, information asymmetries, opportunism, and rent seeking particularly by developers and local authorities during development application process have also been cited to undermine private governance of gated communities (Chen and Webster 2005; Le Goix and Webster 2008; Mckenzie 2005).

4.4 Framing enclave infrastructure system in Nairobi

Enclave urbanism in the context of Nairobi can be explained by urban structures that emerge from a strong economic, social and spatial differentiation. Nairobi's infrastructure pattern is rooted in its history, socioeconomic and physical development processes that have shaped the socio-spatial structure in the city across time and space (see Chapter 2). Colonial and post-colonial economic structures have equally influenced the development of premium networked enclaves in different sections of the city. From its inception, Nairobi has been referred as a 'fragmented city', 'compartmentalized city' and 'divided city' (Charton-Bigot and Rodriguez-Torres 2010). Earlier forms of residential enclaves were as a result of colonial land use planning policies, which emphasized functional and racial segregation (Oyugi and Owiti 2007). Residential areas were differentiated according to race, with the white population living to the west uplands of Nairobi, whereas the native population were restricted to the eastern lowlands.

By 1900, a racially segregated Nairobi covering an area of 18km^2 had been set up by the British rule (Owiti and Olima 2007). Nairobi was zoned into four distinct racial enclaves. The North and East regions comprising of Parklands, Pangani and Eastleigh formed the Asian enclaves. The East and South East region

encompassing Pumwani, Kariokor and Donholm was the African zone. The region between South East and South formed another Asian enclave while the North and West areas including Muthaiga, Upper Parklands, Westlands, Loresho, Kileleshwa and Kilimani were left for European enclaves. In addition to racial residential policies, building by-laws, density regulations, and restrictive rural-urban migration rules by the colonial admiration outlawed natives from using or owning certain areas of the city (Home 2012; Njoh 2009). The racial segregation and restriction of the natives into the city area persisted until 1963 when British rule came to an end in Kenya.

Infrastructure development similarly followed the racial script and was largely shaped by inclusion and exclusion mechanisms. As can be expected, the white enclaves, in addition to the city centre, received premium infrastructure services such as water, drainage and street networks, all at the expense of other areas (Njoh and Akiwumi 2011). This skewed pattern of infrastructure provision persisted through the post-colonial regime to date. In place of race, socioeconomic status has become the main mechanism shaping infrastructure distribution in Nairobi. Different socio-spatial settlements are evident of a fragmented Nairobi. For instance, approximately 55% of Nairobi's population lives on scattered informal settlements that add up to only 5% of the city's residential area (Syagga 2011). The increasing inequality in wealth and income has also meant that economic and political elites strategically occupy well serviced neighborhoods, leaving the poorer masses to wallow in the poorly serviced areas of the city. The socio-spatial polarization is highly attributed to the prevailing (neoliberal) land and housing markets intertwined with land use regulations (Owiti and Olima 2007). The land policies in Kenya have continued to favor the economic and political elite, allowing them unrivalled access to and ownership of landed property (GOK 2004; Syagga 2006). This has resulted into various spatial confines for different categories of socioeconomic class that presents a striking spatial divide. The difference is not only manifested in terms of class type but also of planned vis-à-vis unplanned settlements, each with varying levels, availability and governance arrangement for provision of infrastructure services.

In Nairobi, the concept of a 'gated development' is used chiefly as a marketing strategy to mean an efficiently managed residential neighborhood. Because the pricing of these housing developments is set at a high premium, the market mechanism naturally filters 'unwanted groups' to create homogenous enclaves of medium- to high-income classes. On the demand side, the rising need for a good housing environment with guaranteed services and facilities by the middle- and upper-class drives the construction of gated

neighborhoods. This has in turn fuelled the construction of gated neighborhoods, which boast efficiency, high quality and continuous supply of services to residents. In Nairobi, many of these gated communities have developed their own 'unbundled' infrastructure systems of water, wastewater treatment, security and garbage collection. This is well illustrated by the example of Runda, to which we now turn focus.

4.5 Runda: a case of premium networked infrastructure?

4.5.1 Background to Runda

Runda is located approximately 13 kilometers north of the Nairobi Central Business District. The neighborhood covers an estimated area of 12 square kilometers, bounded by Limuru Road to the west, Ruaka Road to the south, Kiambu Road to the east and coffee plantations to the north. The area is easily accessible to the city centre via Limuru and Ruaka roads. The affluent neighborhood borders two informal settlements, Githogoro and Huruma, which house the majority of the casual labourers and domestic servants working in Runda residences. In addition, Runda neighbors Muthaiga, Gigiri and Ridgeways, all of which are considered exclusive suburbs of Nairobi.

Historically, Runda was a White settler's coffee farm until the early 1970s when the Pan African Insurance Company Limited acquired the land and transformed it into a high-end housing estate.[13] The demand for such a development was prompted by the construction of the United Nations offices at Gigiri in the 1970s. Between 1972 and 1980, the MAE Properties Limited, a real estate subsidiary of the Pan Africa Insurance Company Limited developed the first phase of Runda. MAE designed and oversaw the construction of palatial homes on one- and two-acre plots, which targeted only high-end clients. Following growing demand for similar kind of housing by the elites relocating into the area, MAE developed subsequent phases. Meanwhile, the firm also sold subdivided plots to other real estate investors for residential development in the area. Over the last 40 years, various real estate firms have completed several housing developments in the area, the latest project being a 371-unit housing development by Kings Pride, as Runda Phase VII.[14] Property developers in Runda have ready market in the growing number of diplomats and foreign expatriates working at the nearby United Nations Complex and close-by embassies such as those of the USA and Canada. This is in addition to the Kenyan economic and political elites among whom Runda remains a prized address. The neighbourhood comprises about 1,500 homes housing approximately 11,000 inhabitants (RWL 2012). The

[13] http://www.standardmedia.co.ke/lifestyle/article/2000015401/runda-mae-ridge-property accessed on 27/2/2017
[14] http://www.nation.co.ke/lifestyle/DN2/Kings-Pride-developer-targets-middle-class-with-Runda-homes/957860-2943532-10glwg4z/index.html accessed on 27/2/2017

population is poised to rise in the near future, given the growing number of new housing developments within and adjacent to Runda.

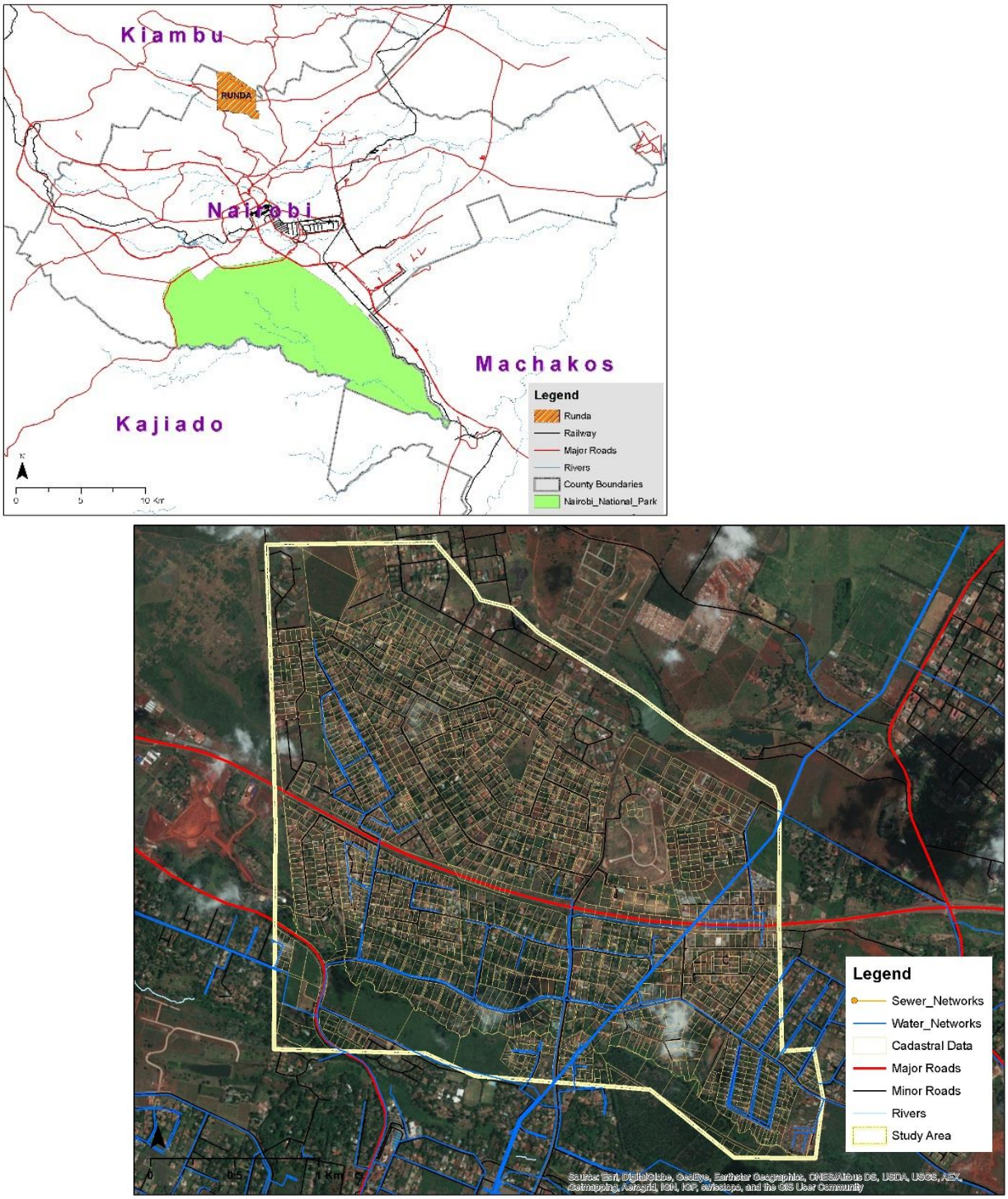

Figure 4-2: Location of Runda within Nairobi

4.5.2 The formation of Runda Residents Association (RRA)

In 1999, Runda residents joined hands to form the Runda Residents and Plot Owners Association. The rise of crimes such as house break-ins and carjacking prompted residents to join hands in seeking a solution to the problem (RRA 2013). The residents together with MAE Properties Limited pinned notices at the neighbourhood's entrance inviting all residents to discuss issues facing their neighbourhood, as well as the possibility of forming a residents association. The meeting attracted 80 residents (RRA 2013). The residents constituted a committee and laid out neighbourhood strategies for enhancing security, among other services such as street lighting, garbage collection and landscaping. The residents also came up with local rules and regulations particularly with regards to adherence to housing development specifications. The residents agreed on an organization structure that consists of a members' general assembly at the top, followed by an executive committee, which oversees activities of several sub-committees, among them environment and development, legal, security, finance, communication and social and welfare (figure 4-3).

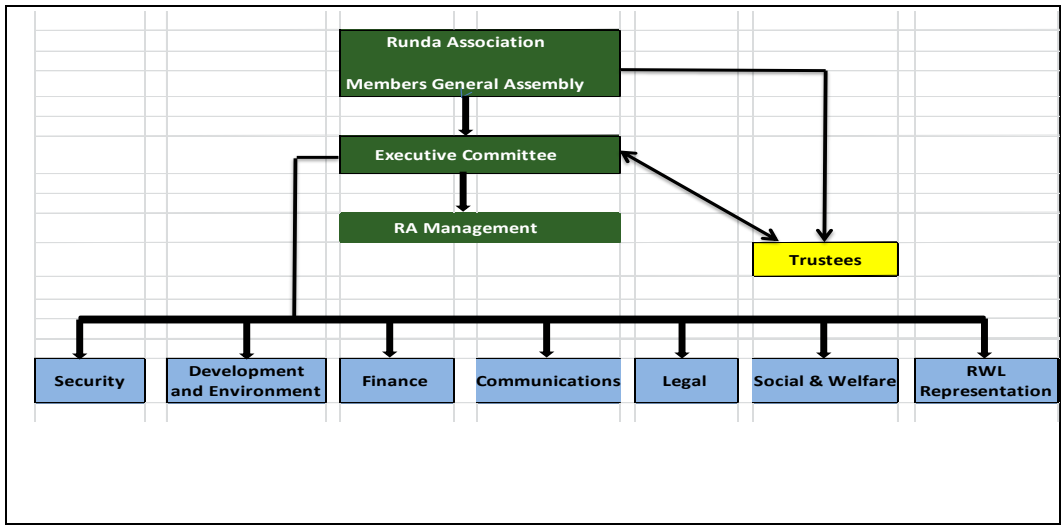

Figure 4-3: Organization structure of Runda Residents Association
Source: RRA

The subcommittees consists of professional residents specialized in the respective fields and who offer voluntary advisory services to the Association. In September 2004, the Runda Residents and Plot Owners Association was renamed to Runda Residents Association and incorporated newer members from recent neighboring developments.

4.5.3 The water supply system in Runda: Actors, financing and operations

As the MAE Properties Limited begun the first phase of housing construction in 1972, Runda was not connected to the Nairobi's central water supply system. At the time, the Nairobi City Council [15] had limited capacity to extend its water networks to the newly developing suburb. In response, MAE came up with the idea of setting up a decentralized private water treatment company that would supply water exclusively to the Runda neighborhood. The idea was financed by the Pan Africa Insurance Company, who registered the Runda Water Limited (RWL) in 1973 as a private company under the Companies Act, Chapter 486 of the Laws of Kenya. By 1975, the requisite investment in water infrastructure had enabled Runda Water Limited to begin supplying piped water to the residents of the Runda neighborhood. Accordingly, the company obtained an operating license from the then Ministry of Water Development and became fully operational from 1975 to date.

RWL sources its water from Ruaka River, one of the tributaries of the Nairobi River that flows across Runda. RWL abstracts raw water from the river at their intake plant situated at MAE properties road within Runda. The raw water is then pumped into the treatment plant located at the company's office premises on Runda Grove. The company has a ground raw water storage tank and a high-level steel tank with a combined storage capacity of 2, 200 cubic metres (figure 4-4). Over the years, the company has undertaken system upgrading and expansion. The current capacity stands at 2,700 cubic metres per day. The company pumps clean water to the distribution lines, which then connect to individual housing units. Each house is metered and billed on a monthly basis. Residents are required to pay their water bills alongside other services offered by the RWL at the utility offices located within Runda.

In 2002, the Pan Africa Insurance Company expressed interest of selling the RWL. It is then that the Runda Residents Association held a special general meeting and reached a decision to acquire the water company from the Pan Africa Insurance Company. The Association applied for a loan facility at the Commercial Bank of Africa to enable them to purchase the water company. The residents' purchase proposal was approved by both the bank and the Pan Africa Insurance Company. In 2003, the Runda Residents Association bought out 75% of Pan Africa Insurance Company's shareholding in Runda Water Limited. Up to date, Pan Africa holds the remaining 25%. The acquisition of RWL by the RRA in 2003 came at a time when reforms in the water sector were being implemented in Kenya through the Water Act of 2002. The RWL therefore realigned its

[15] The forerunner of the current County Government of Nairobi

operations along the key reforms then aimed at commercializing water services provision in the country. Accordingly, the company expanded its customer base from a purely domestic niche to include commercial customers. The customer base grew from an initial 70 to 1500 households, with the potential of co-opting more households from recent housing developments within the area (RWL 2013).

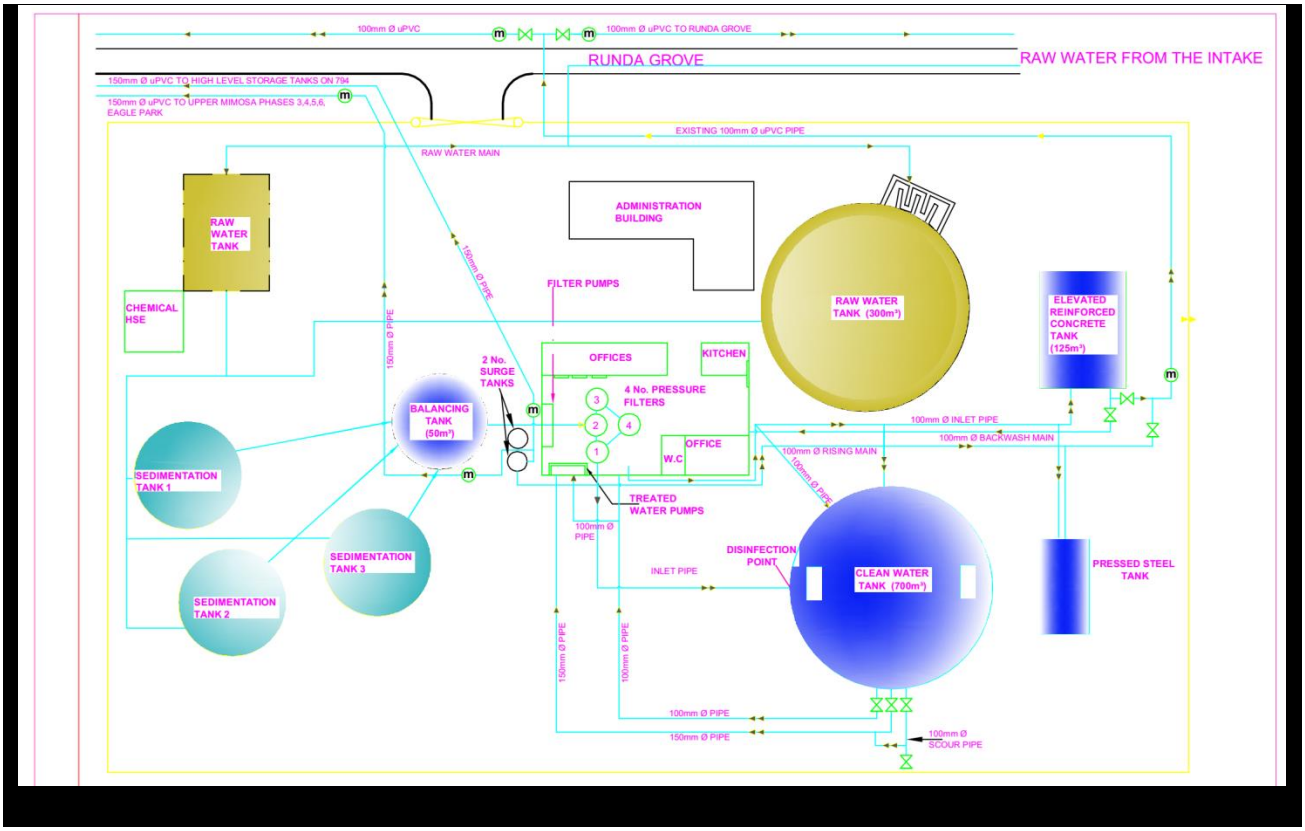

Figure 4-4: Schematic layout of Runda water treatment works
Source: RWL

The new institutional changes brought by the Water Act meant that RWL had to obtain new operating licenses under the new regime. The company signed a new service provision agreement with the Athi Water Services Board (which licenses water service providers within the Nairobi Metropolitan Region) and Water Service Regulatory Board (the national regulator of water services). In addition, RWL is answerable to the Water Resource Management Authority (the national water resource manager) as pertains abstraction of surface and underground water resources. In tune with corporate management practice, the water company prepares five-year strategic plans to guide its future growth, as well as provide effective planning of its resources.[16]

[16] Personal interview with the Technical Manager, RWL, April 2015

The strategic plans lay out the vision and mission statement of RWL which are 'to be a model water services provider' and 'to offer efficient, effective and quality products and services to our customers', respectively (RWL 2013). Besides water supply, RWL provides security, street maintenance, street lighting and garbage collection to Runda residents.

4.6 Appraisal of Runda water supply system

The case of Runda demonstrates that the construction of new and decentralized infrastructure systems have been under way to serve emerging residential enclaves in Nairobi. The private water supply system was a solution to the limited capacity of the public central water system to service the upcoming housing developments in Runda. This is contrary to the assumption of incremental extension of central networks to incorporate newly urbanizing areas to become integrated as advanced in conventional planning models. Faced with this limitation, the MAE properties investors sought a private and separate infrastructure system from the NCWSC, thanks to the economic muscle of the Pan Africa Insurance Company. The actions of MAE properties here indicates a strong role played by property speculators in financing and providing private infrastructure systems. The RWL is licensed to operate as a small-scale private company with its own management structure, water intake plant, treatment plant, storage tanks and network distribution. The company therefore operates independently and as a competitor to the public utility (NCWSC).

The case of Runda questions the adequacy of the 'club realm of consumption' in explaining a homogenous customer base that supports premium service provision. The concept assumes a free will by affluent consumers to spend more on delivery of quality infrastructure services. Yet in Runda, newer developers and property owners have increasingly accused the RWL of charging exorbitant water bills, as reported recently in the press.[17] Some of the new plot owners have taken the matter to court arguing that the company does not allow them the freedom to subscribe to cheaper service provided by the NCWSC.[18] Instructively, RWL charges Ksh 75 per cubic metre of water, while a similar volume of water is charged Ksh 20 by the NCWSC (RWL 2013). While these tariffs appear exorbitant, they are approved by the Water Services Regulatory Board (WASREB) and justified on the basis of economies of scale.[19] Although the NCWSC water mains runs adjacent to Runda and even supplies water to neighboring developments, Runda residents are not permitted

[17] http://www.businessdailyafrica.com/Corporate-News/Runda-Water-locked-in-bills-row-with-residents/539550-2368594-9gr7la/index.html http://www.standardmedia.co.ke/lifestyle/article/2000053572/some-resident-associations-powerful-than-the-city-council/?pageNo=1 accessed on 27/2/2017

[18] http://www.nation.co.ke/news/City-Hall-moves-to-end-Runda-water-monopoly/1056-2523708-qfbogfz/index.html accessed on 27/2/2017

[19] Personal interviews with WASREB official and Technical Manager, RWL September 2014

(by their own association) to make connection to the public utility network. The RWL obtained a zoning permit which restricts other water suppliers from operating within their service zone. This essentially rules out competition, giving RWL exclusive rights to supply water in Runda. This has left disgruntled property owners with no option but to engage the RWL in unending litigation in law courts. Interestingly, RWL has won these cases previously since the law recognizes them as the sole licensed water supplier in Runda, and all developers have to comply with regulations that govern developments within the neighbourhood.

Yet again, residents of gated communities have been projected as passive consumers of infrastructure services pegged on their ability to pay for it. The water supply in Runda however presents mixed reactions to this assumption. While majority of Runda residents can be described as passive and happy consumers of water from Runda Water Limited, a smaller number of the residents have displayed intentions of seeking alternative (and cheaper) water sources. In addition to the court battles mentioned already, some residents have expressed interest to drill own boreholes. This latest move can be read as a way of challenging the services of RWL by seeking individual and independent water supply regime. Interestingly, the RWL acted quickly and put up advisory notices advising the residents against use of borehole water for domestic use, citing high fluoride content in the area. In the notice, the RWL and RRA stated that they were acting under their moral duty to provide professional advice to the Runda residents. In one of the 'advisory notices', The RWL attached a water sample analytical certificate issued by the Water Resources Management Authority that displayed the laboratory results of sample borehole water from within Runda indicating the high fluoride contents. While one cannot overlook the importance of the advisory notice, it is clear that the intention of the residents to drill borehole threatened the RWL's earnings from water sales. Here, residents' actions continue to shape the day-to-day operations of the RWL as the company strives to offer quality services, as well as redefine the social relations among residents and the water company. To quote the Technical Manager, 'Runda residents are not just consumers of services. These are people who are learned. They know their rights very well.'

Unlike the norm in gated communities where residents consciously mobilize themselves for community governance and organization of efficient service delivery, Runda and its service system was originally driven by property speculators as explained already. Meanwhile, residents of gated communities are expected to actively participate in the day-to-day affairs of the residents association. In practice however, hardly do the elite do so. Noting that Runda is a haven for the Kenyan political and economic elites, diplomats and

international expatriates, their personalized participation is limited. That notwithstanding, the high socioeconomic class of Runda residents makes the RRA and RWL very influential agencies in city governance through powerful state and business connections. The Runda Association enjoys significant and powerful professional network from whom they draw advice on matters relating to their living environment. For example, through the Association, Runda residents recently rejected a major government infrastructure decision that involved building a road link through the neighborhood from the Northern by-pass. The residents had successfully sought to guard their posh environment from heavy through-traffic.[20]

Yet again, reliability and unlimited availability of services are the reasons why decentralized systems such as that of RWL are preferred by the high-end users over the regular municipal mains. While majority of Nairobi residents are forced to cope with frequent water shortages and irregular water supply from the public utility, Runda residents boast of their water company, which compared to the NCWSC is deemed more efficient. RWL has so far received three excellence awards from the national regulator (WASREB) for being the best privately owned water service provider (RWL 2015). Going back to literature on premium networked infrastructure, one cannot fail to notice the one-sided narrative of this efficacy. The existing literature does not tell us the extent to which premium infrastructures can fail to meet the expectations of residents or rather how the efficacy is ensured. Field findings from Runda revealed that RWL is not an exception to infrastructure, inefficiencies, failure and break-downs (Graham 2010). The struggles that go behind service provision is well captured in the Technical Manager's remarks:

> There is nothing as difficult as serving rich people. They are not polite when they make calls to complain about water issues. They don't care about the situation because they are ready to pay. So you have to go extra mile to make sure there is water flowing in their taps.'

The disruptions have on occasions changed the way the company offers its services to Runda residents. While the RWL remains an independent water service provider, the company has been forced to create new relationship with the NCWSC through a bulk water purchase system to boost its capacity when its own water reservoir are below optimal level to efficiently supply water to the Runda residents. During dry season when water levels in all rivers recede, RWL is forced to order for water bowsers to deliver water to its clients. Residents have on different occasions been forced to pay and order for water deliveries from externally

[20] Discussions with a four-member committee of RRA, November 2016

sourced water bowsers who purchase water from other parts of the city and resell to individual households in need of the service. The RWL had not envisaged these challenges, mark you, in its earlier years of operation.

The extra water supply arrangement from the NCSWC and water bowsers act to supplement the RWL's dwindling water stock and helps them to keep up with increasing water demand. In this case, the water from NCWSC is first pumped to RWL's water reservoir before redistributing to Runda residents. This does not go well with a section of the residents who believe they should be allowed to have parallel connections to the NCSWS networks so that they can directly pay the lower tariffs of the public water utility instead of being subjected to higher fees charged by the RWL. On the other hand, the return to the NCWSC for bulk water supply has created conflicts between the two companies. The NCWSC has on different occasions accused the RWL for not paying for all the waters supplied to them. More tellingly, there is fear that if the interrelations in the water situation continues, the RWL may be forced to lease its assets and infrastructure to the AWSB and its operation handed over to the NCWSC as a possible way forward. These are just but a few concerns cited during my interviews with the RWL and the NCWSC that indicate the paradox of running enclave networked infrastructure in the wake of water scarcity in Nairobi.

More striking is how the RWL uses water supply as an instrument to coarse members into compliance. Acting within the limits of resources (water and economic capacity), the company raises awareness on sustainable (re)use of water. For instance, the RWL encourages residents to practice rain water harvesting and cut down on watering of lawns using treated water. However, the company receives mixed reactions from different residents. While some residents cooperate by implementing water saving measures, some do not care as they believe they deserve continuous services since paying is not a problem.

Another important aspect confronting the RWL is the task of protecting Ruaka River from pollution and encroachments by urban developments. Over the years, Ruaka River has faced various threats fronted by exigencies of urban development processes taking place in the nearby Ruaka Town, which lies upstream of Runda. The growth of Ruaka has contributed to pollution of the river particularly through poor waste management practices by inhabitants, private developers and the local authorities. There has been rampant developments along the riparian reserve, further destroying the life of the river. However, approval of these developments lie beyond the powers and control of the RWL. Despite the RWL being a major stakeholder in

assessing new development proposals that affect them, relevant local authorities have the final power to make decisions and control development. It should be noted especially that in Kenya, powerful real estate developers have their 'ways' of obtaining approvals from the relevant government authorities even when there is a public outcry towards potential project's negative impacts on the environment. For instance, the Karura Forest which protects the Ruaka River has had its good share of encroachments by new developments (Klopp 2000). Patches of the forest fronting Limuru Road have been cleared to pave way for construction of foreign embassies (Njeru 2010). To sum it all, the pollution of the river and receding water levels pose current and future economic and environmental threat to the Runda water supply system. The uncertain future of RWL was vividly captured when the Technical Manager expressed fear of having no job in the near future if the river and its ecosystem is not protected from urban development pressures. Sadly, this lies beyond the province of RWL.

4.7 Conclusion

The foregoing discussion has presented a nuanced account of the production of enclave infrastructure systems in Runda. As espoused, enclave networked infrastructures are not a recent phenomenon in Nairobi. The colonial infrastructure planning regime greatly influenced the contemporary unequal urban landscape. The post-colonial policies have not done enough to erase the socio-spatial divide created during the colonization era. The liberalization policies brought about by the SAPs in turn promoted strong private sector participation in the provision of public services. The commodification of housing and water services supported by latest post-modernist city visions have increasingly promoted enclave urbanism across the city. The housing developers use socio-economic criteria in forming homogenous urban spaces. On the other hand, a growing upward shift in economic ladder by the Kenyan population in search of better living environment drives the development of gated housing. Driven majorly by real estate speculators, complete housing packages in form of gated communities is shaping Nairobi's infrastructure into several enclave-type of infrastructure pattern.

The case of Runda water supply has challenged the universality and homogeneity of the networked infrastructure model. Enclave-type of developments have promoted fragmented infrastructure systems and patterns across Nairobi. While most urban enclaves reconfigure the existing public utility lines for first-rate water provision, the Runda case illustrates emergence of a total private decentralized water system. The socio-technical arrangement is separate from the NCWSC, largely contributing to fragmentation of city-wide

infrastructure planning and governance into micro-territories. As opposed to infrastructure by-pass that is caused by creation of new premium networks of service delivery diverting resources from existing public utility companies, the Runda water infrastructure can be seen more in terms of a decentralized solution than a premium networked infrastructure.

The Runda case has demonstrated that not all is rosy in managing enclave infrastructures. As observed, some residents challenge the underlying assumption of a 'shared consumption goods' by contesting the high service fees charged by the RWL. The RWL has experienced a growing number of disputes and conflict between individual residents and the Residents Association on the one hand, and between residents and the water company, on the other hand. The resulting conflicts are further shaped by power relations between the residents association and the residents when they battle out their differences in courts of law.

The case of RWL shows that enclave infrastructure systems are governed by powerful private agencies. The increasing role of the private sector and real estate speculators has become very crucial in city governance and infrastructure provision. The roles of these actors from planning, property acquisition, financing, construction of infrastructure and management of urban development cannot be overemphasized. Nevertheless, the state and local authorities remain critical in regulating and enforcing the activities of private developers. More importantly, the state should take a leading role in bridging the inequality in infrastructure access and promoting social justice in infrastructure provision.

As discussed, the RRA and the RWL command power and are able to influence urban development process and infrastructure governance. These sources of power protect the interests and sustains the prestige of urban enclaves. However, we see that RWL is not able to effectively protect the Ruaka River and its ecosystem from urban pollution and encroachment by other powerful property developers. The company only oversees a section of the Ruaka River that flows through Runda Estate but becomes powerless on the rest of the river and its ecosystem that lies beyond Runda. This finding demonstrates that Runda water infrastructure should not be viewed as entirely an enclave in nature; the system is more deeply engraved into broader urban governance encompassing environmental and natural resource management. This interrelationship calls for co-ordination and working together of various state agencies at the national and county government levels to potentially strengthen and support adherence of urban development policies. This way, the capacity of RWL will be enhanced through regulation and control of urban development in a

way that does not cause harm to the sustainability river. In other words, the crucial role of the RWL should be capacited through co-productive activities with the state agencies involved in urban development for better use, control and distribution of water resources.

5. TOWARDS COLLABORATIVE INFRASTRUCTURE PLANNING? THE CO-PRODUCTION OF WATER SUPPLY IN KAYOLE SOWETO, NAIROBI

5.1 Overview

The modern infrastructure ideal has continued to shape how urban services such as water and sanitation are provided in cities across the world. Although the infrastructure ideal remains dominant in national and regional formal planning policies and strategies (Monstadt and Schramm 2017), urban authorities in African countries are increasingly becoming aware of its limitations. This is in response to the rapid transformation of spatial development patterns, demographic trends, socio-economic and environmental factors that have affected the realization of universal and standardized infrastructure systems (Coutard and Rutherford 2016; Kooy and Bakker 2008; McFarlane 2008).The challenge of informal settlements, particularly, has hampered the materialization of the modern infrastructure vision. Not only are planning authorities unable to tame the growth of informal settlements, they are also faced with limited budgetary resources to extend basic services to these areas (Kyessi 2005; K'Akumu 2006; Syagga 2011). Notably, informal settlements present complex socio-spatial planning challenges due to their insecure land tenure, organic settlement patterns and low income population (Watson 2012; Roy 2005; 2009; Arabindoo 2011).These are just but some of the characteristics that complicate the provision of infrastructure services through conventional means within informally developed areas. As a result, low-income population who largely occupy such settlements have remained marginalized in urban infrastructure planning and public service provision.

The difficulty of achieving the modern infrastructural ideal in cities of the Global South (and partly Global North) has seen researchers start to question the ability of monopolistic utility firms to deliver services uniformly across the urban landscape (Coutard and Rutherford 2016; Egyedi and Mehos 2012). The assumption that state utility firms will deliver ubiquitous services across the entire urban area has been widely challenged in the Global South contexts (Gandy 2004; Kooy and Bakker 2008). It is acknowledged that many utilities in the South either lack requisite financial capital, or efficiency in the provision of public goods and services, amid the unfolding rapid socio-spatial transformation. In response to state inefficiencies in delivery of public services, neoliberal policy reforms (structural adjustment programs) promoted by international financial institutions in the 1990s advocated for stronger roles of the private sector in the provision of public services (Bakker 2007). Operating under the cost recovery market principle of 'no fee, no service' (Miraftab 2006), private corporations and utility companies cherry pick high-end areas that promise higher returns at

the expense of poor urban settlements (Graham and Marvin 2001). In this arrangement of convenience, the low purchasing power of low-income populations not only pushes them to the margins of infrastructure service provision, but also puts into question their rightful urban citizenship (McFarlane and Rutherford 2008). To counter these neoliberal policies and their impacts, community and grassroots mobilizations became the new alternative adopted by urban residents to enhance service provision within marginalized quarters (Bakker 2008). However, it is evident that local communities alone are incapable of developing trunk infrastructures due to the large capital outlay involved, besides legitimacy voids that impair community initiatives. It therefore goes without saying that neither the state, market mechanisms, private sector nor community can solely enhance service provision to the urban poor (see also, Mcgranahan 2015; Mcmillan et. al 2014).

The central question then becomes, which is the appropriate institutional arrangement for provision of urban services in low-income areas? There is a lack of consensus on this matter, with each of the three options—public (state), private and community-led initiatives—presenting its own share of limitations. This chapter therefore uses the theory and practice of collaborative planning with a co-production approach to reframe how urban infrastructure services are provided in low-income areas of Nairobi and other cities in Africa. I argue here that more often than not, various actors from different institutions, be it in the form of community-led initiatives, self-help, or public-private partnerships, have been working together to improve infrastructure conditions in low-income areas. In a quest to deliver water services for daily use, the boundaries between and among the various institutional arrangements becomes blurred, resulting in hybrid infrastructure governance and service provision arrangements. Such unorthodox approaches have proven to be relatable with ground realities, thereby widening perspectives and opportunities for reaching the urban poor and the wider city, particularly where conventional servicing models fail.

In Nairobi, public planning authorities are increasingly promoting and forming strategic partnerships with the private sector, individual entrepreneurs, multinational corporations, international donors, NGOS, CBOS and local communities to enhance the provision of services among low-income settlements (Huchzermeyer and Karam 2006). The coming together of these multiple institutions and actors from across the board is important in light of countering the persistent socio-spatial exclusion of low-income populations in infrastructure service provision. This is demonstrated through the empirical case of the so-called *social connection* policy recently implemented across low-income settlements in Nairobi by the Nairobi Water and Sewerage Company (NCWSC). The gist of the social connection policy is to promote partnerships between the NCWSC and

willing stakeholders to subsidize first-time connections of the low-income areas to the central water supply network. A detailed account of the process is exemplified by the case of Kayole Soweto, one of the low-income settlements in the city's outskirts. The implementation of the policy in Kayole Soweto exemplifies a co-productive collaborative infrastructure governance. The process brought together various stakeholders from different spheres of influence outside the water sector who engaged the local community in devising appropriate models and practical tools that significantly contributed towards improving the local water supply situation. Although the aim was to connect the residents to the central networks, the co-production approach in Kayole Soweto followed unconventional means of infrastructure financing, construction and management, making it stand out as an instructive case of alternative infrastructure planning and delivery in Nairobi.

The fieldwork for the collection of empirical material was carried out in two phases. The first fieldwork was carried out between February and April 2016. It involved in-depth interviews with the area chief and 23 local inhabitants randomly selected across Kayole Soweto. I also conducted semi-structured interviews with four officials of the Nairobi Water and Sewerage Company (NCWSC), two of whom were based at the utility company's site office in Kayole Soweto, while the other two were based at the informal settlement regional headquarters at Kariobangi. During the second visit in November 2016, I carried out additional semi-structured interviews with an extra two officials of the NCWSC and one program supervisor of the ongoing Kenya Informal Settlement Improvement Project (KISIP). Field observations were carried out in both instances. Secondary sources include published and unpublished material, socio-economic reports, project documents and web-sourced material.

5.2 Extending collaborative planning through co-production

For long, engagement between public planning institutions and non-state agencies in urban development has pre-occupied participation debates in planning theory (Brownill et al. 2010). The various forms of engagements have elicited a number of conceptualizations based on different intellectual traditions and contexts, majorly from the Global North (Watson 2014). One of the theoretical positions is collaborative planning (Healey 1997; 2003), which I espouse here through its normative and descriptive value. According to Healey (2003), collaborative planning is an approach to understanding and evaluating governance processes, and especially those that focus on developing qualities of place and territory. The utility of collaborative planning lies in its focus on creating fair and inclusive institutional settings for deliberations among different stakeholders (Agger and Löfgren 2008). A collaborative process may be transformative in

terms of changing the practices, cultures and outcomes of place governance through exploring how the design of a process could be made more socially just and inclusive (Innes and Booher 2003; Healey 2003).

Collaborative planning emphasizes interactive relations and some kind of governance process (Innes and Booher 1999; Healey 1997). By governance, I mean a negotiation process for decision-making and collective implementation of urban projects involving active participation of local communities, civil society, state agency and private actors through a bottom-linked partnership (Swyngedouw 2005; Jessop 2002; García et al. 2015). Bottom-linked practices mediate the tension between bottom-up initiatives and top-down policies and policy-making systems by socially innovating in institutional dynamics (Pradel et al. 2013; Eizaguirre et al. 2012). This way, the traditional top-down decision-making and neo-liberal reforms introduced by the state and its agency is counteracted by voices from below (Garcıa 2006).

Collaborative planning involves a variety of stakeholders in long-term, face-to-face deliberations to produce plans or policies through consensus building (Booher and Innes 2002). This normative view of how decision making processes are carried out in terms of consensus building have attracted huge scholarly critiques on this 'communicative turn' in planning theory (Huxley 2000). It has been pointed that the underlying institutional environment in collaborative planning is wrought with multiplicity, diversity and dynamics of value systems, power relations, and interplay of actors with varied interests (Booher and Innes 2002; Healey 1997; Albrechts 2012). The differential power structure among stakeholders may undermine the democratic credibility of processes, especially where local communities do not hold equal power as other stakeholders in influencing outcomes (Swyngedouw 2005). In her critique, Hillier (2003) proposes a theorization based on 'agonistic pluralism' (see also Mouffe 1999; 2000) to dislodge and contest the Habermassian idealization of rational consensus-building. Drawing on Foucaultian ideas of power, Hillier (2003) argues that agonism productively explains some of the power games enacted in planning decision-making and suggests that a political perspective makes planning a mobile and contextual activity. A similar position is maintained by Pløger (2004) who sees the need for contemporary planners to work with and within strife to sharpen collaborative processes. Recently, Brownill and Parker (2010) have suggested that the planning debates on state-society engagement are in a 'post-collaborative' phase. By post-collaborative, the authors emphasize the continuity of difficulties of having to deal with diverse perspectives, range of contexts and conditions within which participation occurs in contemporary planning.

While there is a huge literature indicating the idealistic nature of collaborative planning, my aim here is to search for a different path of rethinking how to enhance collaboration amid growing differences in values and competition for limited resources by multiple urban actors. More importantly, I strive for a view from the South (Watson 2009) to unearth some of the underlying assumptions inherent in planning theory whose origins is informed by western ideals. I do this by introducing the concept of co-production, which I argue, can help reframe how we understand collaborative planning especially in Global South contexts. Owing its origins in public administration and development studies, a trans-disciplinary approach to co-production can enrich planning theory in wider contexts, especially in southern cities where all manner of institutional arrangements are constantly being deployed to meet daily existential needs of urban inhabitants.

5.2.1 From collaboration to co-production in collaborative planning

The concept of co-production is largely traceable to the work of Elinor Ostrom, which observes the crucial role that citizens play in producing public goods and services of consequence to them. Ostrom (1996) defines co-production as the 'process through which inputs used to produce a good or service are contributed by individuals who are not ''in'' the same organization (p, 1073). Co-production in Ostrom's definition emphasizes the direct involvement of citizens and the state to create synergies through different contributions but in a complementing way. This way, co-production promotes a decentralized governance structure and fosters social capital as communities organize around service provision and management (Ostrom 1996).

Ostrom's definition of co-production has triggered various interpretation of the concept by different authors from varied disciplines (Bovaird 2007; Mcgranahan 2015). For instance, Joshi and Moore (2004), introduce 'institutionalized co-production' to refer to the 'provision of public services (broadly defined, to include regulation) through regular, long-term relationships between state agencies and organized groups of citizens, where both make substantial resource contributions' (p, 40). According to them, institutionalized co-production is more applicable to weak states and public agencies that struggle to meet demands for public goods. The authors argue that in such contexts, it is the norm to find mixed or hybrid arrangements that fit into none of the standard categories as agencies interact and cooperate with one another in a diversity of ways to provide services. These arrangements that almost defy categorization often function effectively in circumstances where more conventional models of service delivery fail (ibid.). Joshi and Moore therefore argue for an 'institutionalized co-production' to broadly capture these hybrid arrangements, which remain undefined, informal and renegotiated in contexts where 'Weberian' institutional boundaries are blurred (p,

40). Criticizing Joshi and Moore (2004) for excluding the role of professional providers, Bovaird (2007) redefines co-production as the 'provision of services through regular, long-term relationships between professionalized service providers (in any sector) and service users or other members of the community, where all parties make substantial resource contributions' (p, 847). This engagement in co-planning and co-delivery of services may create complex adaptive systems, with very different dynamics from that of provider-centric services (ibid.).

More recently, Diana Mitlin reinterpreted co-production beyond an idealized 'Weberian' model of bureaucracy to the messy reality of day-to-day service delivery in cities of the Global South (Mitlin 2008). She observes that co-production is not only a means to improve service delivery but also, a political strategy used by grassroots groups and social movement organizations to enable individual members and their associations to secure effective relations with state institutions that address both immediate basic needs and enable them to negotiate for greater benefits (p, 339). Mitlin argues that a level of engagement with the state is required to reform practices and standards, and to provide needed policies, actions and investments to address the urban poor's plight. She grounds her conceptualization through an elaborate example of the Slum Dwellers International's (SDI) co-production strategies and activities, which arguably is different from standard 'participation' or 'partnership' arrangements. According to Mitlin, co-production proves effective when grassroots organizations operating at different level of settlements are linked to international NGOs through a process of federating that expands access of local organizations to wider support networks. Co-production in this context is rooted in empowerment of the urban poor by transforming state-community governance relations through learning exchanges.

A few urban scholars have recognized the usefulness of co-production in enriching participation debates in planning theory (Watson 2014; Albrechts 2012). In the same spirit, I attempt to find ways of improving collaborative planning using a co-production approach. The question begs, how can we incorporate co-production to improve collaborative planning? First, I suggest that co-production provides the necessary missing link between planning or policy formulation and grounded actions. Whereas collaborative planning concerns how to shape the planning process, adding a co-production approach, I argue, intertwines the planning phase with implementation and management of urban programs. The concept is more applicable especially in delivery of infrastructure services such as water and sanitation (Banana et al. 2015; Mcgranahan 2015; Mcmillan et al. 2014; Ostrom 1996).

Secondly, co-production improves governance structures and may lead to institutional (structural) reforms where deliberate consensus-building may prove difficult. Incorporation of co-production transforms decision making by engaging deprived communities from plan initiation through to material realization. Also, co-production provides flexible possibilities with local communities having equal grounds to initiate co-productive collaborative processes rather than sticking to state-defined formal participation formats (see also Mitlin 2008; Westerink and Groot 2017). The active participation of local communities beyond state-defined spaces may greatly transform governance processes (Cornwall and Coelho 2007; Miraftab 2004; Holston 2009).

The third import of a co-productive perspective is that it moves away from the traditional viewing of stakeholders in a clear-cut boundary of 'formal' and 'informal' actors in urban development processes (Rhodes 1996; Joshi and Moore 2004). Instead, co-production views the engagement of multiple actors in a more diffused and fluid process of power sharing and partnerships (Bovaird 2007; Watson 2014). A co-production approach implies a win-win situation where the focus is not necessarily on who has the power but on the collective division of labour and responsibility in order to achieve a place-based solution to an identified problem. This is not to say that co-productive activities are without power imbalances and conflict. Rather, these are not central issues in co-production as they are in collaborative planning debates. Perhaps more research is needed in this area (Watson 2014).

5.3 Before the birth of the social connection policy in Nairobi

The provision of adequate and affordable water services to all citizens remains a challenge for public utilities in Kenya (K'Akumu 2006). Amid this challenge, public institutions have lately attempted to respond to the plight of the urban poor with an aim to bridge the persistent socio-spatial discrimination in water supply. The current pro-poor approach by state agencies can be explained through a needs-based and rights-based approach. Needs-driven approaches are largely pushed by marginalized low-income communities and civil society groups across the country, while rights-based approaches are enshrined in the current constitution and national water policies (GOK 2002; 2010). After decades of being shut out of city governance and neglect in public provision of services, communities living in informally developed areas joined forces and formed collective voices aimed at improving their living conditions. The mobilization started in the 1990s when the Kenyan government was clearing and evicting households living in informal settlements in urban areas using edicts grounded in colonial housing policy (Weru 2004).The evictions were done without any compensation to the victims, further worsening their situation. At the same time, the Kenyan state was at the height of

implementing the Structural Adjustment Programs, which drastically reduced public expenditure on public services (Chitonge 2014). The harsh economic times and brutal evictions triggered the low-income population to mobilize each other into an active social movement under the umbrella of the National Federation of Slum Dwellers (NFSD). The federation champions the rights of the poor in cities across Kenya and is affiliated to the international NGO, Slum Dweller International (SDI) (Weru 2004). The NFSD works closely with local and international civil society groups in pushing for public services and land tenure security for the urban poor (Karanja 2010).

All together, the civil society groups carried out street protests and engaged in direct confrontations and court battles with the state in pushing for inclusionary measures for the poor in city governance (Weru 2004). However, the state employed combative reactionary measures to the street protests that mostly turned violent. The marginalized groups therefore, changed tack and sought to pursue negotiation with state actors instead (Weru 2004). Continuous state-society engagements in negotiations improved communication and social relations. After lengthy negotiations, the state radically reviewed its planning policies and adopted pro-poor strategies of settlement upgrading in place of slum clearance (GOK 2004). This meant improvement of land tenure security, housing conditions and provision of basic services for the low-income areas in the form of settlement upgrading (Muraguri 2011). Following this policy change, the Kenyan government, with support of international development agencies such as the UN-Habitat and World Bank, has sunk huge sums of money towards settlement upgrading programs across the country. Cases in point include the ongoing Kenya Informal Settlement Improvement Project (KISIP)[21] launched in 2011, and the Kenya Slum Upgrading Programme (KENSUP)[22] implemented since 2004. Given the centrality of water, improvement in service supply became an entry project into the settlements. However, water supply remained piecemeal and devoid of long-term term effects due to heavy reliance on external funds through which the upgrading programs were being supported.

In 2007, the Ministry of Water and Irrigation institutionalized the National Water Services Strategy (NWSS), which advocates for implementation of pro-poor strategies targeting households living in informal settlements across the country (GOK 2007). In accordance with this national framework, the NCWSC (operator) and the

[21] Kisip project http://projects.worldbank.org/P113542/kenya-informal-settlements-improvement-project-kisip?lang=en accessed on 26/3/2017

[22] http://mirror.unhabitat.org/content.asp?cid=668&catid=206&typeid=13 accessed on 26/3/2017

Athi Water Services Board (AWSB, asset holder) institutionalized an informal settlement water reform to improve water and sanitation services in Nairobi's informal settlements in 2008. Through a joint effort, the utility companies formulated new strategic guidelines that provide settlement-specific strategies and programs to increase coverage, affordability and sustainable access to safe water services in Nairobi's low-income areas (NCWSC and AWSB 2009). Importantly, the guidelines provide direction for promoting partnerships between the NCWSC and other stakeholders to increase transparency of water interventions for recipients and partners. The guidelines state that a partnership-based framework should provide an entry point for broader inclusive and participatory approaches that empower local communities and build local capacity. Subsequent changes included the formation of a new informal settlement regional office that saw the NCWSC employing a team of sociologists for the first time. The sociologist team helps with the social component of services to informal settlements, as the utility now acknowledges the inadequacy of a purely engineering approach (NCWSC 2011). The Water and Sanitation Program, Africa (WSP-AF) of the WB provided capacity building throughout the process.

In 2010, Kenyans passed a new constitution that recognizes the right of every citizen to adequate and clean water supply (GOK 2010). Public utilities are therefore mandated to supply water to all citizens without bias, as citizens on the other hand demand their constitutional right. The implication of this constitutional provision has been the initiation of various water projects by the utility companies within low-income areas to offset the persistent and existing service inequalities in urban areas. On its part, the NCWSC came up with the social connection policy for Nairobi's informal settlements and low-income areas (NCWSC 2011). The NCWSC launched the policy in March 2011 to help the poor connect directly to the company's network through a subsidy plan. Specifically, the policy provides guidelines for the social connection fund, utilization of the funds, roles and responsibilities of different stakeholders, eligibility criteria, connection fees and tariffs. To better understand the policy, I now focus on the case study in Kayole Soweto, which was the first settlement to benefit under the new policy.

5.4 Implementation of the social connection policy in Kayole Soweto

Kayole Soweto is one of the low-income settlements in the eastlands of Nairobi (figure 5-1). The settlement was originally formed in the 1970s following a presidential order to relocate households from the current Embakasi Barracks. Before the resettlement occurred, the then Nairobi City Council and a military team of surveyors prepared land use and sub-division plans that included market areas, schools, hospital and other

public spaces to serve the residents. Each relocated resident was issued with an allotment letter that permitted them to occupy and develop the allotted plot. However, the low socio-economic status of the households did not allow them to build approved housing structures, giving the settlement a quasi-formal appearance. Over the years, the settlement has experienced massive growth as more and more temporary structures were put up to accommodate incoming populations. The resultant demography is a mix of original allottees and newer populations who form the majority tenant population in the area. Currently, the settlement is home to about 89,000 people distributed across 22,400 households in an area measuring about 20 acres (Mwangi et al. 2015).

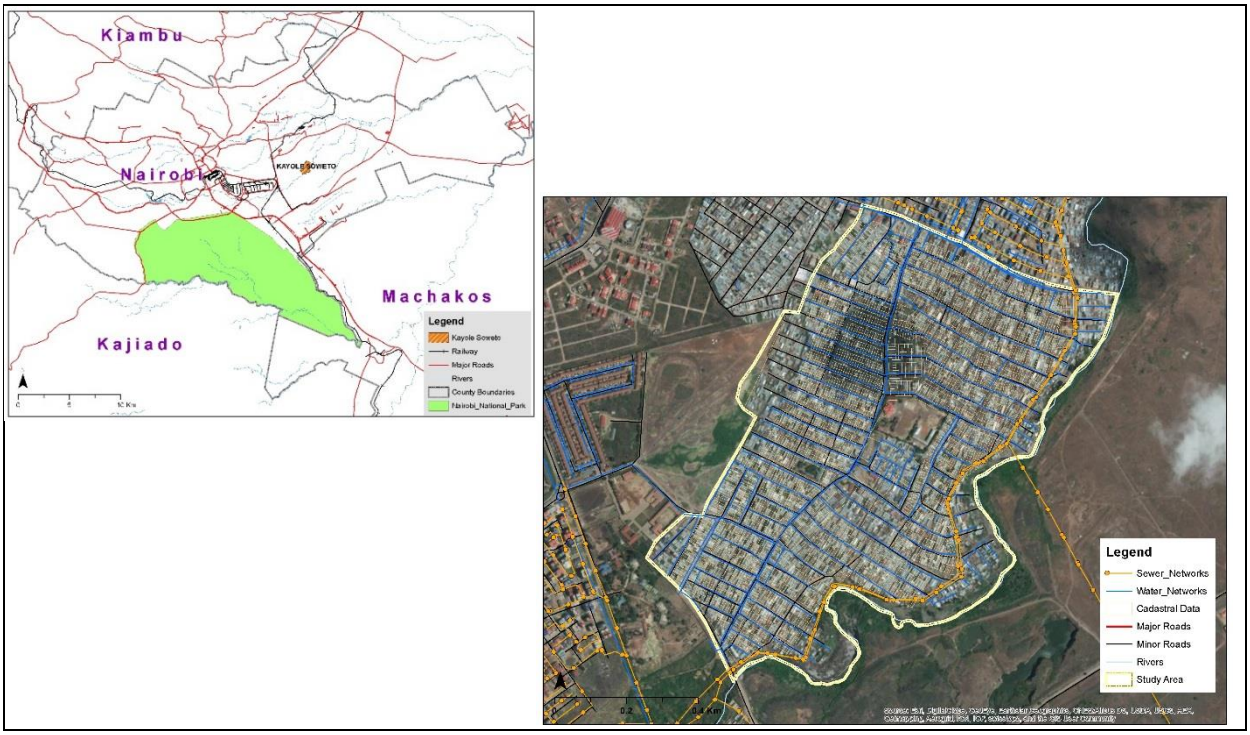

Figure 5-1: Location of Kayole Soweto within Nairobi (L); and the regularized settlement showing latest water reticulation networks

As in other informally developing areas of Nairobi, residents of Kayole Soweto have been depending on expensive and low quality modes of water supply ranging from boreholes, small-scale vendors to clandestine water connections. However, in 2011, the settlement was selected for infrastructure upgrading under the framework of the ongoing countrywide KISIP program. At the time I conducted fieldwork in February 2016, the main access roads, storm water drainage and electricity were fully installed. With improved infrastructure and tenure regularization, poorly constructed housing structures are increasingly being replaced with more permanent housing structures (figure 5-2). The infrastructure upgrades provided the necessary foundation

for the NCWSC to come in with the water and sewer component. For instance, the land tenure was regularized with clearly marked spaces for road networks and wayleaves for laying complementary infrastructure such as water and sewer pipes (refer to Figure 5-1). This made it easier for NCWSC to connect the settlement to the larger city water network through the grid system. However, the option remained unaffordable for the residents who still had to raise connection fees and subsequent bills. It is within this context, and with the aim of bridging the financial deficit, that the NCWSC launched the social connection policy in Kayole Soweto in October 2012. Locally, the project is dubbed *maji mashinani*[23]. It is important to note that the implementation process did not follow a linear process. Accordingly, the subsections below are interdependent and are only arranged sequentially to aid the discussion along the main theoretical strands presented earlier in section two.

Figure 5-2: Changing housing typologies following infrastructure upgrade in Kayole Soweto

5.4.1 Stakeholder mobilization

Stakeholder mobilization here should be seen at the settlement and policy levels. As already explained, community mobilization in the 1990s instigated major national policy changes that transformed the way public institutions treat marginalized communities. In Kayole Soweto, it was important for the NCWSC and the local community to arrive at a renewed social relation. This follows years of public neglect in provision of water services to the community. As a result, water supply function was taken over by independent water vendors who thrived on reselling water at higher prices. The entrance of the NCWSC into the settlement would therefore mean eradicating the water vendors from the water business, creating animosity and antagonistic relations. To overcome this animosity, the NCWSC conducted various grassroots negotiation with community members, right from the project's conception to implementation. The NCWSC undertook various practical

[23] Maji mashinani is Swahili word for water at the grassroots.

steps, first by engaging a team of Community Development Assistants (CDA) and sociologists to help in sensitizing the community about the project objectives and benefits. With the help of local administrative leaders, the CDA and sociologists steered knowledge exchange at community forums that included door-to-door sensitization exercises. Secondly, the NCWSC conducted smaller stakeholders' meetings and discussions in each of the nine zones of the settlement before holding major community forums that brought everyone together. Thirdly, the NCWSC opened a local office within Kayole Soweto that proved instrumental in further mobilization of the residents. Here, community members are welcomed to ask any questions regarding the project as well as sign up for the social connection, and enjoy other customer care services. The fully functioning office provides a direct link between the residents and the utility company.

Through the mobilization process, the NCWSC realized the import of strengthening its staff capacity and having a proper mix of skills required to roll out the project. For instance, the extensive community outreach programs conducted by the CDAs helped to improve public relations, gain community acceptance and win trust of the project by the local stakeholders. During the field interviews, it was pointed out that failure to reach an agreement with the local cartels that have for long controlled the water business in the area would have led to project sabotage.[24] Previous cases of infrastructure vandalism, theft and interference with project installation through organized attacks by rowdy youths have been synonymous with public water projects in low-income areas. In other cases, local cartels and area leaders have been quoted demanding bribes before they can support the project (Ambole 2016). Grassroots mobilization was therefore a critical process to ensure project ownership and support by all affected interests.

Meanwhile, the NCWSC together with the AWSB undertook benchmarking exercises by organizing specialized skills training courses with other regional utilities. This was crucial for expansion of knowledge and skills exchange among various professionals in sharpening the program based on feedback from ground personnel. More importantly, the forums promoted mobilization of funds and collaborative partnerships towards the material realization of the project. During the benchmarking presentations, the utilities invited key stakeholders in the water sector including financing institutions drawn from commercial banks, and multi-international donors such as the World Bank and central government sector players. After seeing the feasibility of the initiative, the *maji mashinani* project attracted technical and funding support from the WB, telecommunication companies and micro-finance institutions.

[24] Interview with a NCWSC's sociologist at Kayole Soweto, March 2016

5.4.2 Community training and socio-economic survey

Having gained the trust and acceptance to go on with the project, the CDAs spearheaded training sessions with some of the community members. The purpose of the training was to develop residents' skills to conduct socio-economic household surveys through use of structured questionnaires. The team was familiarized with the questions, how to ask the questions, how to fill in answers and how to carry out analysis. The trained members together with the NCWSC undertook an elaborate socio-economic survey across the settlement. Various important socio-economic data were collected from the survey. This included the willingness of residents to pay the prescribed utility's connection fee and subsequent water bills, weekly and monthly average household income, literacy skills (reading and writing), type and place of work, and mapping of existing water facilities, to name but a few attributes.

The collected data helped the NCWSC and the residents to ascertain the cost of water investment in the area vis-à-vis the current water availability options. From the socio-economic survey, 35 privately operated water stand posts were mapped across the entire settlement. There was also a community borehole that sold water at Kshs. 2-3 per 20-litre Jerrican. Nevertheless, borehole water in the area is not preferred for cooking and drinking due to high fluoride content. This forces households to buy water from private vendors who sell a 20-litre Jerrican of piped water between Kshs. 15 and 20. The price can shoot up to Kshs. 50 during periods of severe water scarcity. This cost translates to Kshs. 100-250 per cubic meters, which is much higher compared to the lowest tariff offered by the utility at Kshs. 18. 70 for between zero to 10 cubic meters. Moreover, some of the residents walked longer distances to fetch water from adjacent connected neighbourhoods. Being aware of the implication of this disparity, Kayole Soweto residents showed high interest and demand for cheap and safe water from NCWSC.

At the same time, the average household monthly income stands at Kshs. 12,000, with majority of the residents depending on casual unskilled and semi-skilled jobs or self-employment in small-scale businesses within and around the settlement. Although the residents were willing to pay to be connected directly to the NCWSC'S network, the inconsistent and low-income pattern could not allow majority of the households to afford the initial connection fee charged by the utility company. Payment of accumulated water bill on monthly basis proved to be another challenge for most households as they depend on daily wages. The NCWSC's connection requirements thus remained a barrier for both the utility and community in extending water services to the settlement.

5.4.3 Infrastructure financing and construction

Using data from the socio-economic analysis, the NCWSC in partnership with the WB's WSP and the residents developed a flexible financial model that took account of the daily and weekly income profiles of Kayole Soweto households. To begin with, the AWSB received funds to help in the capital investment cost of network expansion into Kayole Soweto through the WB's Water and Sanitation Services Improvement Project (WASSIP) under KISIP. The amount was augmented by the NCWSC's own contribution to the social connection fund. The utility company channels 0.5% of the collected monthly water revenue towards the social connection fund kitty to help in infrastructure improvement projects in low-income areas across Nairobi (NCWSC 2011). Together with the WB's grant, the funds facilitated the construction of about 18 km pipe network within the nine zones of Kayole Soweto (WSP 2015). However as stated earlier, individual households were to pay for the connection fees, which is valued at about Ksh. 13, 000. Inclusive with this amount is Kshs. 5,195 for piping and fitting, Kshs. 2,500 for domestic connection fee and Kshs. 2,500 to cater for the meter rent (Mwangi, Otiego, and Ndakorerwa 2015).

Owing to the limited financial capacity of households to meet the connection fee, the NCWSC sought additional financial support on behalf of the local community. The utility approached several commercial lending institutions in search of a suitable loan facility. After several attempts and lengthy negotiations, the NCWSC entered into a partnership with K-Rep Bank, a local micro-finance bank. K-Rep Bank eventually agreed to extend a loan facility amounting to Kshs. 10 million to the utility (WSP 2015). In this case, the NCWSC is the loan guarantor and takes the performance risks of loan repayment. In addition, the NCWSC secured another funding from the Output Based Aid (OBA) subsidy, which is a result-based financing mechanism of the WB's Global Partnership on Output-based Aid (GPOBA) that provides monetary incentives to utilities to expand basic services. The aim of the OBA funds is to enable low-income households to access subsidized micro-loans through the utility. Put together, the funds were enough to facilitate pre-financing of water connections to initial 2,200 households.

To qualify as a beneficiary of the loan, each household was required to pay a basic minimum and a one-time non-refundable commitment fee of Kshs. 1,648 to the NCWSC. In cases where individual connection was unattainable, several adjacent households were allowed to join forces and contribute towards one yard tap that would serve them collectively. Upon completion of connecting 2,200 households to the main water network, the NCWSC received a 40% OBA subsidy, which drastically reduced the K-Rep bank loan to half.

The remainder half of the loan is what is transferred to connected individuals. The residents are allowed to repay this loan through a staggered and flexible arrangement as and when money is available over a duration of three years. The emphasis here is on consistency and commitment to the loan repayment, instead of unrealistic fixed terms. Computed, this roughly translates to about Kshs. 150 per month and Kshs. 38 per week for every connected household. This cost is considered affordable by majority residents, compared to the amount of money spent buying water from local vendors on a daily basis.

Another factor that considerably cut the cost of water extension to the settlement is the use of community labour in surveying, construction and laying of the water pipe infrastructure (figure 5-3). Community members were involved in digging trenches and laying down the water pipes while others specialized in fixing water meters. Engaging the community labour did not only cut the cost of construction but also enhanced the construction skills of those who labored. The skills acquired in this way have proved useful especially during repair and maintenance works, where trained members get paid for services rendered to the utility company and individual households. Also, community labour promoted active community participation leading to higher project ownership and goodwill.

Figure 5-3: Community members digging trenches and laying water pipes with technical assistance of the NCWSC's staff in Kayole Soweto
Source: NCWSC 2013

5.4.4 Water bills and loan repayment

As explained earlier, a monthly payment system was not practical among local residents, given their fluctuating income patterns. Therefore, the NCWSC had to think creatively on how to collect the water revenues away from the monthly billing as is the normal practice. Besides, many residents lacked postal addresses to facilitate the billing process. Taking advantage of the recent technological innovations in the water sector, the utility entered into partnership with Safaricom, a leading telecommunication company in Kenya who helped in creating an innovative and flexible way of billing named *Jisomee Mita.*[25] *Jisomee Mita* is a self-meter reading and electronic mobile phone-based billing system that enables residents to use their mobile phones to send their own meter readings, query and receive current water bills and pay the utility using Safaricom's mobile money transfer service platform *M-Pesa*.[26] Other mobile money transfer services are also permitted via the ICT platform. Residents are also notified of their outstanding micro-loan balance and can repay the loan through the same system. Safaricom waives the costs of the short message service for the residents and charges only the utility company 80 cents for the response message. This makes it affordable for the residents to use the service as many times as possible throughout the month. The technological innovation also saves on printing and paper use on monthly billing and receipts, not to mention the time saved. More importantly, involving residents to read their own meters and remit the payments as and when they get money enhances the mutual trust and transparency between the residents and the utility company.

Apart from the *Jisomee Mita*, the utility manages and updates the residents' connection database at their on-site office in Kayole Soweto. The office also provides day-to-day corporate services to residents who are not yet using the *Jisomee Mita* billing system. The location at Kayole Soweto eases counter-checking of residents' account statements and correction of any errors in meter reading as well as extends customer care services closer to the ground. However, the use of *Jisomee Mita* is highly encouraged as the system has proved efficient in remittance of water bills and loan repayment. For instance, the utility claimed a doubled collection efficiency from 52% to 102% over a period of five months since the adoption of the *Jisomee Mita* billing system in June 2014 (WSP 2015). Accordingly, the monthly loan repayment performance was averagely Kshs. 650,000 against the monthly target of Kshs. 730,000 over a 16-month period (ibid). The

[25] Jisomee mita is Swahili word for 'read your own meter'
[26] M-pesa stands for mobile money

utility therefore projects that investment costs will be recovered according to the initial timelines if residents maintain the recorded consistency.

5.4.5 Project status and scalability

At the time of my second fieldwork in November 2016, 2,500 individual connections had been realized, surpassing the initial target of 2,200 social connections. A total of 25 kilometers of water network has so far been constructed (WSP 2015) and residents can now access water from their door steps. However, the high city-wide demand for water vis-à-vis supply forces the NCWSC to implement a water rationing program that sees Kayole Soweto receive water supply once per week. Individual households thus employ various coping mechanisms by way of water storage such as investing in 20-liter Jerricans or higher capacity containers depending on the affordability and space availability within one's household. Water containers occupy significant room space, limiting the number and size which a household can keep. The cost of buying higher capacity containers is also prohibitive. For instance, residents here have to part with about Kshs. 11,000 to purchase a 1000-liters plastic container while a 20-liter Jerrican costs between Kshs. 100 and Kshs. 150. In addition, residents still rely on buying water from the nearby community borehole besides harvesting rain water using open plastic containers.

The practical solutions introduced under the *Maji Mashinani* have shown possibility for scaling-up the social connections to other low-income areas across Kenya and beyond. This is despite the water rationing challenges which is not likely to end in the foreseeable future unless the utilities drastically expand their water sources and curb unaccounted for water among other measures. According to a recent press statement by the NCWSC, plans are under way to extend the reach of *Maji Mashinani* to other under-served informal settlements in Nairobi. This include Kawangware-Gatina, Kangemi, Embakasi River and Matopeni Spring Valley, which altogether will see more than 200,000 city residents connected to the main network (NCWS 2012). In Kayole Soweto, the social connection approach is now being used to connect the residents to the city sewer network under the ongoing Kenya Informal Settlement Improvement Project. Elsewhere in Malindi town, the relevant utility is financing the social connections through community contributions and utility's corporate social responsibility allocations. Meanwhile, water utilities in Mombasa, Mumias and Eldoret are in preparatory stages of modifying the social connection policy to suit their respective situations. The WB has shown support to these utilities by leveraging additional financing from willing domestic private sector, be it

commercial banks like K-Rep and from the GPOBA that provides subsidies to facilitate household connections under the social connection policy.

5.5 Conclusion

The foregoing discussion has demonstrated that low-income populations can obtain basic services such as water supply through co-productive collaborative processes. More importantly, it is through co-production that pro-poor policies can be translated into ground practices and its benefits realized in material terms. For instance, the social connection policy was realized in Kayole Soweto through a series of co-productive activities among and between partners that collaborated with the NCWSC. The partners were bound by a collective responsibility of improving lives of Kayole Soweto's residents, whereby each partner's role impacted on the larger outcome. Sharing a collective responsibility also meant that each partner was ready to compromise on conventional way of doing things in order to achieve the project objectives in the most feasible and practical manner. For example, it is was the first time to engage a micro-financing institution in funding water connections for low-income settlements despite past fears of high credit costs and loan recovery. However, Kayole Soweto exemplifies how multiple partners including residents can collaborate to make such financing feasible. The partners came up with an innovative financing that combined Output-Based Aid and micro-credit with mobile money transfer service to assist poor residents to access water services. Co-production therefore can breed innovation in the way infrastructure is provided under contexts of limited budgetary allocation.

As the Kayole case demonstrates, co-production enhances local engagement of affected community groups not just as participants in decision making processes, but also as shapers and makers of public decisions eventually transforming institutions and governance processes. For instance, the utility was forced to modify its billing options to suit the socio-economic profiles of the residents. Whereas the social connection policy was the utility's own initiative to expand services in low-income settlements, active involvement of local residents shaped the design and delivery of water services from the onset. The improved social relations between the residents and the utility enhanced mutual trust, allowing the parties involved to work together more effectively and establish long-term relationships and project ownership. Allowing residents to be responsible for delivery of part of the project's components not only enhanced their day-to-day engagement with the utility, but also built local knowledge and skills that lead to long-term empowerment. In place of a

top-down implementation plan, the social connection policy embraced a co-production approach that promoted the poor's access to wider socio-political resources that met their basic needs.

Lastly, a co-production approach in delivery of basic infrastructure services has fundamental socio-political implications in terms of up-scaling and mainstreaming practical solutions in subsequent public policy making. Co-production is useful where feedback is fed into the original policy allowing revisions and modifications for further local adaptability. In the long run, co-production triggers political influence in changing the status quo particularly where residents are highly involved in the process. More important is the way in which both needs-driven and rights-based interventions get reconciled through a co-production process that empowers previously marginalized groups. In the process, the boundary between 'formal' and 'informal' as well as between 'provider' and 'consumer' gets blurred during infrastructure planning and service delivery. Co-production thus proves effective in transforming collaborative planning processes by radically changing the way plans are created and executed. Therefore, a co-productive collaborative planning is not only a method of improving service delivery, but also a way of establishing new networks among different stakeholders with different capabilities and knowledge that respond creatively to todays' complex urban problems.

6. BEYOND BORDERS: PERI-URBAN WATER SUPPLY IN RUAI, NAIROBI

6.1 Overview

Conceptual studies on peri-urban infrastructure systems have remained scarce in scholarly literature. It is only until recently that a few scholars have attempted to theorize 'suburban infrastructure' (Addie 2016; Filion and Keil 2016). Even then, the socio-technical configuration of these infrastructure systems remains underexplored by urban scholars (Dodson 2013). African cities in particular, have received limited research attention on this subject. This is despite the fact that today, peri-urbanization is a significant trend shaping forms of expansion on urban peripheries across the region (Allen et al. 2016; 2008; Mabin et al. 2013; Mbiba and Huchzermeyer 2002; Todes 2014). Under the current wave of African urbanization, peri-urban spaces are experiencing significant social, economic, environmental and political transformations (Aguilar 2008; Woltjer 2014), all of which call for an urgent attention in addressing the research lacuna on peri-urban dynamics, especially those shaping peri-urban infrastructure systems. Given the crucial role that infrastructure plays in supporting lives and economic health of newly urbanizing areas, I believe that peri-urban infrastructure(s) presents an important conceptual and empirical construct in deconstructing the 'networked infrastructure' city model within rapidly urbanizing cities. Accordingly, the proposal presented in this Chapter is not only an academic exercise; it is a practical premise for urban planners and policy makers mandated with managing the peri-urbanization exigency and the attendant infrastructure demands that comes with it.

The importance of bringing peri-urban infrastructure into the core of urban research cannot be overemphasized. Urban politics of the center-periphery raise critical insights as well as heuristic tools into the epistemology of peri-urban studies. The peri-urban has always been regarded as spatially marginal to the built-up core (Young and Keil 2014). To upend their past marginal representation, peri-urban areas should be considered as an extension, thus integral part of the urban and constitutive of urban theorization (Aguilar 2008; Keil and Addie 2015). Isolating peri-urban areas inhibits a comprehensive view of interrelatedness of the periphery and the city core (Allen 2003). This connection is not only in terms of ecological footprints, but also social, economic and political processes shaping forms across the entire urban environment (ibid.). More fundamental is the multi-scalar nature of peri-infrastructure, which not only serves the peri-urban constellation but supports the functioning of the entire urban region (Young and Keil 2014). Therefore, 'without their inclusion within new governance spaces that equalize powers between the center and the periphery, the

futures of both [peri-urban and core city] are jeopardised (Keil 2015: 52). It is this task of bringing the importance of peri-urban areas into urban scholarship that is taken up in this Chapter.

The Chapter explicates the complex interaction of the networked infrastructure ideals with spatial growth beyond the city core. This is achieved by elucidating the contextual spatial development of the peri-urban as a site of socio-technical and socio-political transformation, beyond the limits of a centralized infrastructure planning system. The empirical material draws from a field study conducted between February and April 2016, and November 2016 in Ruai—one of the peri-urban settlements of Nairobi. The study sought to understand (1) the interplay between local socio-spatial development dynamics and water infrastructure and service provision; (2) the interaction between the networked water infrastructure system and other models of water supply; and (3) to flesh out conflicts and complementarities in the co-existence of multi-models of water supply in Ruai. Empirical data was collected through in-depth interviews with 18 residents of Ruai, including two village elders. Semi-structured interviews were conducted with three planning officials of the County Government of Nairobi and two officials, each from the responsible water utility companies (Nairobi Water and Sewerage Company, and Athi Water Service Board). Project documents, grey literature (newspaper articles, blogs and relevant companies' websites) alongside published material also provided significant data for analysis.

6.2 The peri-urban and its infrastructures: conceptual perspectives

To date, there is no universally accepted definition of the term peri-urban and/or peri-urbanization[27]. The difficulty of finding a common ground is attributed to the highly dynamic nature of the peri-urban space and contextual local specificities of each peri-urban area. In as much as peri-urbanization is now a global phenomenon (Keil 2011; 2013), its universalization cannot override particularities of forces shaping the process (peri-urbanization), the form (peri-urban) and lived experience (peri-urbanism) in different cities. Moreover, peri-urban spaces manifest differently even on the same city, making it difficult to generalize. Despite the conceptual difficulties, there is a wide consensus of viewing the peri-urban as a transition zone, a process and an intermediary between the urban and rural (Allen 2003; Friedmann 2011; Webster, Cai, and Muller 2014; Winarso, Hudalah, and Firman 2015). This chapter derives from this fluid view and approaches

[27] Different terminologies are used to describe the same urbanization phenomenon. For example, suburbanization is commonly used in the Global North contexts. The chapter uses the notion of peri-urbanization as it is commonly applied in sub-Saharan African cities. The definition given in section two has been applied in reference to both North and Southern contexts. See (Keil 2011; 2013: Mabin et al. 2013).

peri-urban as an ever-changing socio-spatial construct, dynamic and in motion from one state to another (from rural to peri-urban to urban). Peri-urbanization hereby comprises demographic and economic growth with spatial expansion on urban peripheries, and emergence of new centrality patterns (Ekers et al. 2012). This definition has been applied in recent studies on African peripheral urban expansion and arguably fits within the rapidly urbanizing context of cities there (Mabin et al. 2013). The way of (daily) life in this space is what is referred to as peri-urbanism.

The transition character of the peri-urban is observed in terms of spatial form, a changing socio-economic group and a dynamic demographic profile (Allen 2003; Douglas 2006; Woltjer 2014). Aguilar (2008) and Woltjer (2014) observe that the peri-urban takes many forms and may not be uniform nor consistent in all directions from the core of cities. For instance, Aguiler (2008) states that the size and structure of the city, land values and land use in the immediate periphery influences the pattern of peri-urbanization. Depending on the factor, some peri-urban areas may indicate a compact and extensive developments while others manifest small urban patches with open spaces or even more, a corridor type of development (ibid.). More importantly, peri-urban spaces are path-dependent based on the economic, political, cultural and environmental histories of the locality (Ekers et al. 2012). Demographically, peri-urban population comprises heterogeneous groups (Allen 2003) which creates variations in wealth and social status (Douglas 2006). For instance, high middle-class groupings coexist among low-income in-migrants, natives and squatters. It is important to note that these social groupings are transitory, depending on the individual socio-economic progression.

The dynamic and heterogeneous nature of the peri-urban complicates its governance. Varying institutions, practices, discourses, ideologies and representations interplay to shape how the peri-urban is produced, contested and experienced (Ekers et al. 2012). The everyday life is marked by power relations, inequality and marginalization. These social relations have profound effect on the development trajectory of the peri-urban. Peri-urban governance is confronted with competition for autonomy among the national, regional, and local state agencies on one hand, and active private sector actors as well as civil society groups (NGOs and CBOs) on the other hand (Allen 2003). The co-existence of such diverse interests, groups, activities and institutions pose practical problems in developing policy options for the peri-urban (Allen et al. 2006). The peri-urban thus becomes a critical space requiring innovative planning and governance approaches in

dealing with competitive and fragmented institutional landscapes (Legates and Hudalah 2014; Winarso et al. 2015).

6.2.1 Peri-urban infrastructure systems

As stated in the introduction, peri-urban infrastructures inspire new ways of conceptualizing and understanding urban infrastructure. This section attempts to offer theoretical insights of how peri-urban infrastructure can be conceptualized within the available limits of scholarly work on the subject. In theorizing suburban infrastructure, Addie (2016) argues that it is important to demystify the way infrastructure is (1) physically embedded in suburban landscapes; (2) produced and performed through place-based suburban governance and socio-spatial dynamics; and (3) supportive of suburbanization and suburban way of life. The author develops a heuristic conceptual device through a tripartite dialectics namely, infrastructure *in* suburbs; infrastructure *of* suburbs; and infrastructure *for* suburbs. This categorization is not ontologically exclusive but aids to unpack diverse uses, relations and ambiguities presented by different socio-technical arrangements of suburban spaces (Addie 2016). Notably, peri-urban infrastructures transcend territorial confines of their spaces both conceptually and empirically. Therefore, infrastructure *in, of* and *for* suburbs promise new ways of centering the periphery by revealing the multi-scale, unequal power relations, marginalization and centrality of peri-urban infrastructure governance (Addie 2016; Filion and Keil 2016; Ekers et al. 2012).

Infrastructure *in* suburbs derive from their mere location there. However, they support functional logics and material flows that are not dependent on their positioning in the suburb. Their planning, development, governance and political economies is restructured and conditioned elsewhere (Addie 2016). These infrastructures are exposed to imperatives of global competitiveness as they are attuned to globalization rather than localized suburbanization. The outside forces significantly impact on living experience of local inhabitants as well as development trajectory and spatial imaginaries of the suburb. A case in point from Nairobi is when the state, local authorities and private developers acquire large tracts of land on the city's outskirts for development of large shopping malls, warehouses and new satellite cities. Major infrastructure projects such as power plants, highways, telecommunication utilities, water networks and sewer treatment plants are then proposed at the urban fringe areas. These infrastructures are not specifically for the local inhabitants but serve powerful economic elite's business interests. The emphasis is on exchange value of the peri-urban through (neo)capitalist peri-urbanization trends (Harvey 2012).

Infrastructure *of* suburbs are predominantly developed by local institutions, communities, landscapes and governmentalities (Addie 2016). The infrastructure is developed outside the centralized system in response to state and market deficiencies. The infrastructure corresponds to people's way of life, production and lived experience of a networked space (Allen et al. 2016). Here, the peri-urban provides a good illustration of shortcomings of conventional planning systems, in particular that of the networked infrastructure model. Filion and Keil (2016) refer to a global phenomenon of 'infrastructure deserts' with respect to non-conventional and informal variants in emerging and existing suburban landscapes. Infrastructure deserts take multiple forms. For instance, they can range from absolute lack of access to clean water supply, to relative terms such as being cut off from the primary city's infrastructure networks. In both terms, inhabitants are left to rely on second rate, slower and often more expensive means of water supply. Meanwhile, more privileged social groups gain access to first class, faster and cheaper infrastructure networks. Arguably, peri-urban infrastructure carry with them fragmentation, marginalization and inequality (McFarlane and Rutherford 2008) resulting in a splintered infrastructure pattern (Graham and Marvin 2001). Infrastructure is unevenly made available depending on the wealth and power of different social groups living in various parts within the peri-urban zone.

The absence of and/or partial coverage of networked infrastructure in urban fringe areas creates complex socio-technical configurations. Loose and highly differentiated socio-technical assemblages are adapted to specific peri-urban contexts of spatial planning, materiality, technologies and modes of living (Ahlers et al. 2014). For instance, water supply is made possible through a mix of connection to a centralized system on one hand, and individual and collective dwelling initiatives on the other (Allen 2010; 2012). To a large extent, water supply is left to micro-enterprises and self-help arrangements (Simone 2004) that step in to fill the gap or the absence of a networked water supply. These mechanisms are needs-driven and support necessities of life (Allen et al. 2006; Gandy 2006; McFarlane et al. 2014).

Infrastructure *for* suburbs shape resource flows necessary to support suburban growth and ways of life (Addie 2016). This is done through extension of infrastructure networks to functionally integrate suburban space and its people to central cities. Despite not achieving full coverage in most urban areas especially in the Global South, the 'modern infrastructure ideal' has remained a powerful fiction model in planning for newly developing peri-urban areas (Allen et al. 2006; Bakker et al. 2008; Kooy and Bakker 2008). It should be noted that the provision of networked infrastructure in peri-urban areas is met with spatial and socio-political

difficulties. On one hand, there is governance of the peri-urbanization majorly by the state, accumulation and private authoritarian apparatus (Hamel and Keil 2015) while on the other, there is production of peri-urban land (Harris et al. 2012). Infrastructure decisions are thus influenced by multiple conflicting interests, which determine how different socio-economic groups are impacted. Eventually, the distribution of infrastructure becomes the source of geographical and social advantage and disadvantage (Filion and Keil 2016). For instance, Allen et al. (2006: 333) allude the failure of the networked infrastructure to respond to peri-urban water needs due to:

> a legacy of decades of supply-led engineering approaches with high operating costs and under-utilized investment, unrealistically high standards of per capita service to formal areas of cities and *a general disregard for the needs of unregulated or "illegal" urban and peri-urban settlements* (my emphasis).

In brief, peri-urban areas are often fraught with infrastructure tensions compared to the city proper. For most of the Global South cities, it is in such spaces that infrastructure deficits particularly of water and sanitation abound (Allen et al. 2006). Filion and Keil (2015) attribute the deficiency and inequality in suburban infrastructures to neglect as much focus is given to central infrastructures and premium network spaces. Yet peri-urban areas will continue to face severe infrastructure stress as much of the current and future urban growth is absorbed there (Filion and Keil 2016). The continuous and rapid transition, economic polarization and sprawling nature of peri-urban spaces further exacerbates the gap between the rate of peri-urban development and infrastructure provision. On the positive side, the peri-urban can become a site of infrastructure innovation and experimentation as the area continues to be developed.

6.3 Setting the context: peri-urbanization and infrastructure development in Nairobi

Peri-urbanization in Nairobi is a consequence of unprecedented urbanization experienced across the city. Population increase from natural growth and rural-urban migration significantly shapes urbanization dynamics in the city. Increased pressures from this population explosion have resulted in spatial sprawl of the city into the surrounding former agricultural land. The scarcity of land, affordable housing and economic opportunities within the confines of the city centre has pushed people, entrepreneurs, real estate developers, international agencies and state agencies to locate on the peripheries. This is because peri-urban areas offer relatively affordable land for urban expansion and new development. Large-scale land acquisitions in fringe areas can be noted by the rise of new satellite cities such as Tatu city (a 2,500 acre Greenfield development,

18 km north of the city centre) [28] and Konza Technology City (a 5000 acre Greenfield development, 60 km south of Nairobi).[29]

Peri-urban development in Nairobi has been accelerated by improvement of the transportation infrastructure. The national state, with the support of international agencies, has injected huge capital into road infrastructure and a standard gauge commuter rail. Major road corridors cutting across the Nairobi metropolitan region namely the Northern, Southern, Eastern and Western bypasses have greatly shaped the pattern of urban sprawl. These infrastructure projects are part of flagship projects earmarked in the Kenya vision 2030, a national development blueprint aimed at transforming the country into a middle-income economy by 2030 (GOK 2008). Although the aim was to achieve a planned transport oriented land use development in the Nairobi region, the bypasses have generated haphazard human settlements and real estate development across peri-urban Nairobi. Businesses and commuters have relocated strategically on the city's outskirts, taking advantage of the improved linkage and accessibility to the city center.

Despite improved transportation networks, basic infrastructure services such as water and sanitation have not received equal treatment in peri-urban Nairobi. As such, people settle in the peri-urban zone majorly because of affordable housing options and good road linkage. There is a widening gap between water infrastructure development and accelerated peri-urban growth. Unlike transportation infrastructure which is planned at the national scale, provision of water infrastructure lies with the local government—the Nairobi County Government (NCG) through its subsidiary utility company—the Nairobi Water and Sewerage Company (NCWSC). NCG is also responsible for spatial planning, as well as managing and guiding development control across the city. However, the rate of peri-urban development has outstripped the capacity of NCG to enforce spatial development control as well as in provision of adequate water supply. As a result, large parts of the peri-urban areas are not served by the utility's networked system of water supply. This is well illustrated in the Ruai case, to which I now turn.

[28] http://www.tatucity.com/ accessed on 5/8/2016
[29] http://www.konzacity.go.ke/ accessed on 5/8/2016

6.4 The case of Ruai water infrastructure dynamics

Ruai is a peri-urban settlement located approximately 30 kilometers east of the Nairobi Central Business District (figure 6-1). According to the 2009 national population census, Ruai hosts 35,961 people over an area of 98 square kilometers (GOK 2010).

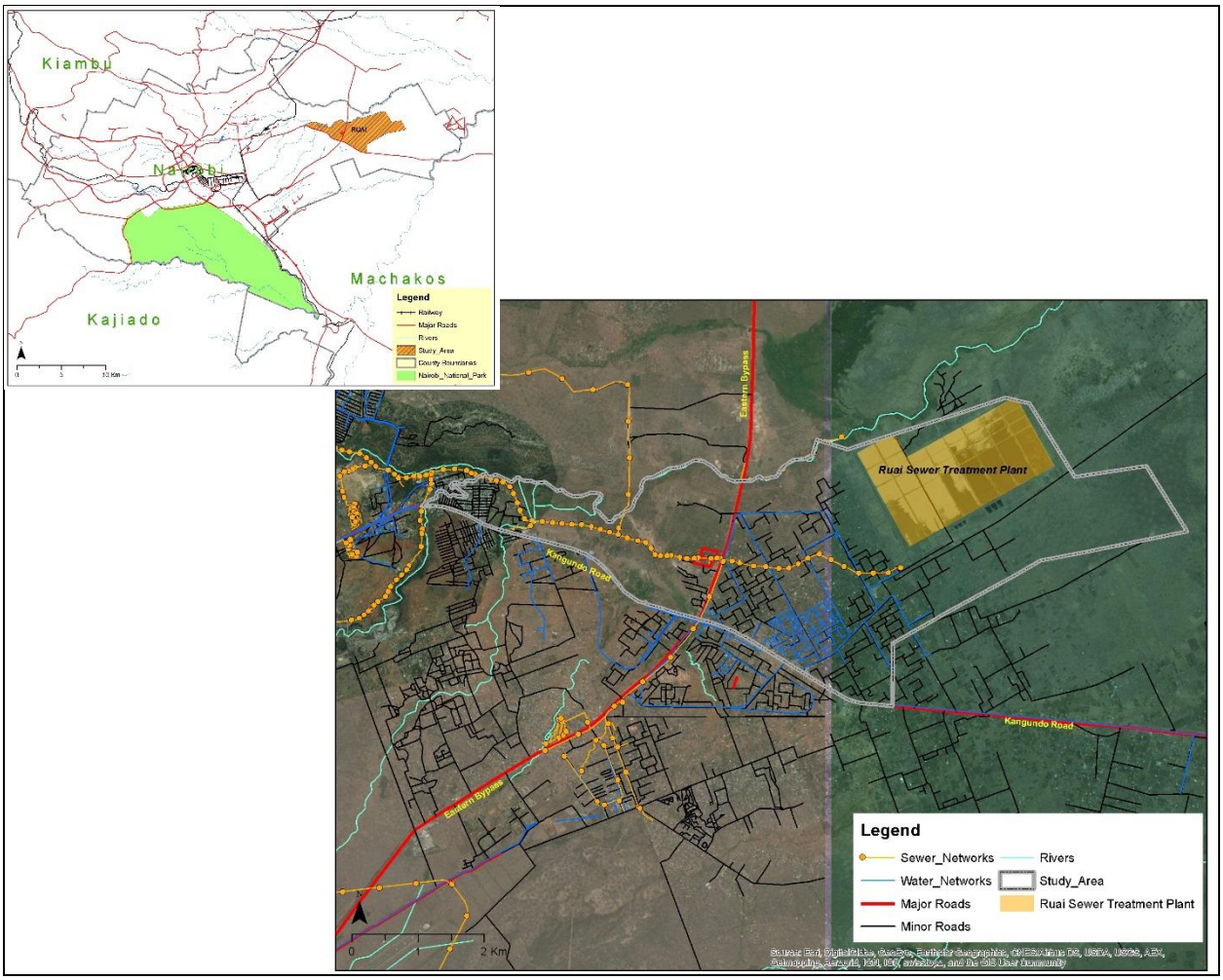

Figure 6-1: Location of Ruai within Nairobi

The settlement has continued to receive in-migrants from both urban and rural areas over the years. For instance, following the post-election violence of 2007, internally displaced persons (IDP) were relocated to the Embakasi IDP camp[30] within Ruai. Besides, low-cost housing cooperatives have been active in the area through land acquisition and housing development for their members[31]. The urban middle-class have also

[30] http://www.standardmedia.co.ke/article/2000067607/ruai-idps-resort-to-sewage-for-farming/?pageNo=1 accessed on 5/8/2016
[31] http://nachu.or.ke/community-housing-projects/ accessed on 5/8/2016

bought land and built their homes there to evade the high rents charged in multi-tenancy apartments closer to the city centre. The population influx from mixed and heterogeneous socio-economic groups thus, characterize and is reflected in the demographic composition and spatial development of Ruai.

Ruai is linked to its surrounding through the Eastern bypass and Kangundo Road (Figure 6-1). It therefore serves as a dormitory town to Nairobi and nearby satellite towns such as Thika, Ruiru, Juja and Kangundo. The completion of the Eastern bypass in 2012 has had tremendous effect on socio-spatial development of Ruai. Land speculation has changed land value in the area, leading to irregular land subdivisions instigated by formal and informal land markets. The former agricultural land with single-dwelling residential houses has transformed almost overnight into a vibrant urban centre with a major economic node at the intersection of the Eastern bypass and Kangundo Road (figure 6-2). Major supermarkets, institutions (education, health and administration) and real estate developers have moved in fast, giving rise to multiple land uses. Administratively, Ruai falls within the jurisdiction of the Nairobi County Government as the sole body in charge of spatial development control and provision of basic services.

Figure 6-2: Vibrant commercial centre in Ruai

6.4.1 Local development dynamics, planning and water infrastructure provision in Ruai

Ruai's spatial development dynamics have greatly influenced its planning and provision of water infrastructure. For a long time, Ruai was considered a remote place with expansive undeveloped land. As such, Ruai was not included in the initial spatial and infrastructure development plans prepared for Nairobi. To begin with, colonial development plans limited the spatial extent of the city's growth. For example, the first plan for Nairobi made in 1989 only covered an area of 18 Km^2. The objective was to provide a spatial guideline

for Nairobi as a railway depot. A second plan was prepared in 1927, with Nairobi as the settler capital. This plan had an extended area measuring 77 km^2. A third plan for Nairobi as a colonial town was prepared in 1948, this time for an area measuring 83km^2. All these while, Ruai remained beyond the municipal planning limits (see figure 6-3 on changing boundaries of Nairobi). When Kenya gained its independence in 1963, Nairobi experienced massive rural-urban migration necessitating the formulation of a new plan to accommodate the growth. The Nairobi Metropolitan Growth Strategy of 1973 was thus prepared to guide growth and development of Nairobi up to the year 2000. It is in this 1973 plan that the city's planning boundary was extended to include Ruai within the city area boundaries, measuring 696km^2—the current geographical area of Nairobi city. Consequently, the Nairobi Integrated Urban Development Plan prepared in 2014 after the expiry of 1973 plan maintains similar spatial extent.

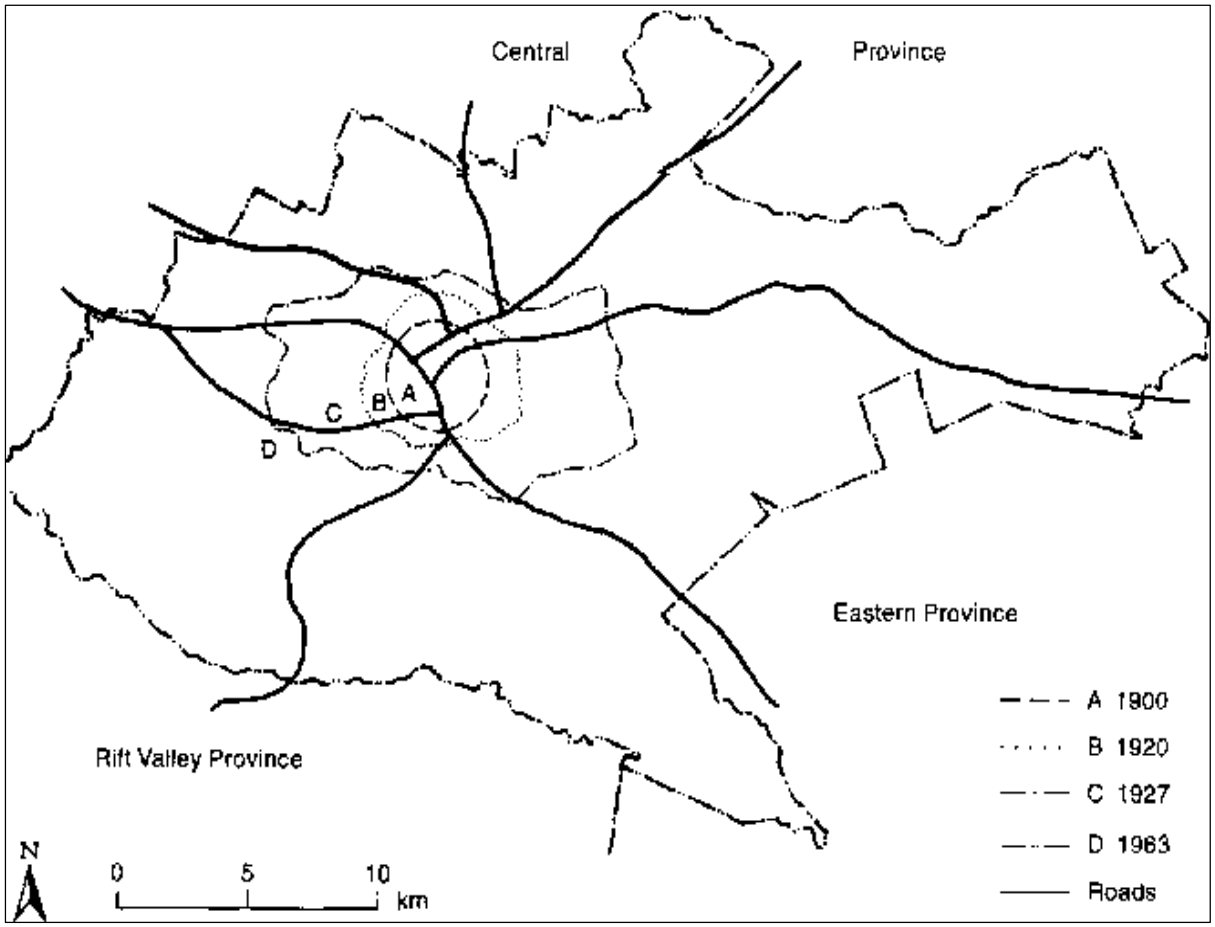

Figure 6-3: Nairobi boundary changes 1900-1963
Source: Obudho and Aduwo (1992)

The above outlined spatial plans for Nairobi had implications on water infrastructure development trajectory of Ruai. First, the centralized water infrastructure system developed during the colonial period only covered city limits delineated by the spatial plans. Ruai was thus completely cut off from the urban infrastructure system at the time. Secondly, although Ruai was later incorporated within the city's jurisdiction in the 1973 and 2014 plans, the area has remained at the periphery of core planning exercise and infrastructure provision by both the Nairobi City County (NCC) and the Nairobi Water and Sewerage Company (NCWSC). During interviews with city planners at the NCC, it became evident that Ruai has no local physical development plan to guide its spatial growth. Land use-wise, Ruai is classified as an agricultural and residential area under the Nairobi City Development Ordinances and Zones of 2004 (figure 6-4). Compared to the central business district, industrial, mixed commercial and high-rise residential zones, this agriculture-cum-residential area has not been given significant importance in the extension of water networks. Ruai is one of the zones with the least network coverage of water supply. Thirdly, the functional-low density level envisioned for Ruai is not economically attractive for a capital infrastructure investment. Coupled with financial constraints of the Nairobi County Government and the water utility company, significant extension of water network into Ruai is not foreseeable in the near future.

ZONE	AREAS COVERED	GC %	PR %	Dept Ref. Map	TYPE (S) OF DEVELOPMENT ALLOWED	MIN. AREA (Ha.)	REMARKS/POLICY ISSUES
16	**Baba Dogo** • Industrial • Residential **Ngumba/Ruaraka/**	80(s) 50(u) 35(s) 25(s) 50(s)	300(s) 100(u) 75s) 25(u) 200(s)	CP/FP/XXX	Industrial Zone Residential (Mixed Residential Development	0.05 lower if comprehensive	High Density Residential
17	**Githurai 44 &45** **Zimmerman** **Kahawa West** • Commercial • Residential • Industrial	50(s) 50 50 50	200(s) 100 100 75 100		Industrial Zone Residential (Mixed Residential Development		• Replete with unplanned developments hence "Blanket approval" vide TP resolution of 18/7/97
18	**Kasarani** • Clayworks • Clay City • Sports View • Mwiki • Njiru • Ruai	50 50 25	100 200 25	CP/FP/XXX CP/FP/XX	• Agricultural • Residential Mixed Development	• 2.0 • 0.05 on sewer • 0.1 ha. if not on sewer • lower min. size if land buying company	Area has potential for residential developments (invasion by land buying companies and land speculators) Industrial not attractive here
19	**Special Scheduled Area Outside Nairobi Boundary** • Githurai Kimbo • Wendani • Kahawa Sukari			CP/FP/XXX	Agricultural Residential (Mixed Development)		• Area fully influenced by city dynamics • NCC not in control of development • Overwhelmingly dependant on services of the city

Figure 6-4: An excerpt from the Nairobi City Development Ordinances and Zones (2004) indicating the development provisions of Ruai

On the other hand, network extension for domestic water supply is confronted with local land use dynamics that shape Ruai's development. Land developments in Ruai are fronted by different actors with diverse interests affecting how and which infrastructure is provided in the area. The major land use decision that has shaped development of Ruai over the years is the construction of the largest sewage treatment plant in the area. The Ruai sewage treatment plant was constructed between 1968 and 1969. The sewage plant occupies approximately 650 hectares with a land reserve for future expansion measuring 662.8 hectares.[32]The treatment plant receives 80% of Nairobi's waste water including sewage. Recently, the Nairobi County Government made proposals to construct a new sanitary land fill facility within the land reserve of the sewerage plant. Despite the physical location of the sewerage plant, Ruai is not connected to the central sewer system (with exception of NCWSC's workers estate). More importantly, decision making regarding siting of such facilities are beyond the reach of local inhabitants. Such high-level technical decisions have impacted on lived experience of Ruai inhabitants. Their day-to-day life is affected by such infrastructural decisions that do not address their immediate basic needs. Over the years, clean water supply has continued to be overshadowed as city planners seem to perceive Ruai as a dumping place of city's wastes.

Yet another powerful land use dynamics affecting water infrastructure provision concerns land speculation. Speculative activities were initially instigated by the construction of the sewage treatment plant. The plant opened the area as a road link was constructed to ease access to the facility from and to the city centre and Kangundo Road. Electricity lines were also extended in the area making Ruai attractive for settlement. The NCWSC was first to develop a housing estate for its workers.[33] Speculation was heightened by the recent completion of the Eastern bypass, which connects Ruai to the larger metropolitan region of Nairobi. Following these recent infrastructure projects, large agricultural land holding companies such as the Embakasi Ranch embarked on rampant land subdivision and sold plots to its shareholders and other buyers. Land quickly changed hands under various tenure arrangements creating land conflicts in its wake. Multiple land holding models therefore coexist against making it difficult for public control of individual development interests. Majority of the buyers developed their land into residential homes while those fronting road networks developed commercial buildings. The resultant environment is an incongruent mixed type of development largely taking place outside development regulations of the Nairobi County Government. The irregular plot subdivisions and subsequent (self-built) building developments do not adhere to space requirements to allow

[32] Field interviews with NCWSC's staff stationed at the Ruai sewage treatment plant, November 2016
[33] Field interviews with NCWSC's staff stationed at the Ruai sewage treatment plant, November 2016

proper infrastructure utility lines extensions. Instead, land development has gone ahead of infrastructure provision, making it a complex environment for any conventional planning and infrastructure provision to take place.

6.4.2 Socio-technical assemblages of water supply in Ruai

Ruai exemplifies a multi-modal water supply pattern mobilized through lived socio-cultural practices of the inhabitants. The socio-technical assemblages reflect wider and internal power relations shaping distribution of water networks. Water networks are unevenly distributed geographically depending on socio-economic status of consumers. This in turn influences reproduction of daily social water supply practices and consumption patterns of locals.

As stated earlier, the Nairobi Water and Sewerage Company (NCWSC) is responsible for water supply in Ruai. However, connection to the central utility lines is not a homogenous and neutral process. To be connected to the central line, an applicant is supposed to present a registered land title deed for his/her property. In addition, the applicant is required to pay Ksh 5,000[34] connection fees to the utility company. These requirements favour and disfavor different groups living in Ruai. First, given the rampant land transactions as earlier elaborated, majority of self-built homes and businesses without legally recognized land documents are left unconnected. Secondly, the economically weak population consider the connection fees to be out of their reach. During field interviews, small-scale entrepreneurs and a section of the residents decried the costly and bureaucratic nature of the application process. To their experience, even after managing to raise the Ksh 5,000, it could take several years before the lines are laid. And to 'get things done quickly', one may be forced to part with extra moneys as high as Ksh 20,000. [35] Their ability cannot be compared with well-off groups for instance, large commercial establishments, big institutions, private owners of multi-tenancy residential flats and the middle-class who are easily connected to the central water system thanks to their deep pockets. Moreover, installation of pipe works is not a guarantee for a continuous flow of water, a problem that is partly attributed to the city-wide water rationing by NCWSC. In cognizance of the city-wide expanding water demand against limited supply, NCWSC pumps water twice per week into the corridor that serves Ruai. This means that if the pressure is maintained throughout the distribution line, connected members receive water two days in a week. Field interviews however indicate that sometimes

[34] Exchange rate, Ksh112 equal 1 Euro
[35] Focus group interviews with Ruai residents, March 2016

water supply is reduced to once a week and even so, for only a few hours while at bad times, it could take up to two weeks before water runs through their taps.

The uneven network distribution and intermittent water supply by NCWSC has produced different survival mechanisms of getting water by those living and doing business in Ruai (figure 6-5). Generally, Ruai residents look up to those connected to NCWSC water mains for clean water supply. Connected households, commercial establishments and institutions play significant role as intermediaries for subsequent water supply to the rest of the population. On days when NCWSC's water flows through their taps, and upon filling their own reservoir tanks, some connected customers sell water (clandestinely) to the rest of the community. Owing to the inconsistent water supply by NCWSC, majority of these connected establishments have also invested in underground water sources. Borehole and wells have been serving the area way before the entry of NCWSC. For example, the NCWSC's workers housing was served by a borehole until 2005 when the estate was connected to the central networks.[36] Notably, the rate of sinking boreholes has increased, with more new developments coming up in the area as NCWSC is not able to respond adequately. Borehole water is pumped into pipe networks laid by individual developers into storage tanks, from where water is distributed into people's homes. Apart from selling water at a strategic point within their premises, borehole owners distribute water to neighboring developments through pipe connections paid for by the new developer. A water meter is then installed at every new connection to facilitate monthly billing.

In as much as sinking boreholes promise consistent water supply, residents complain of the water's salty taste, teeth discoloration from mineral concentration and traces of soil particles. Local residents have branded water from boreholes as *maji ya chumvi* (salty water) while water from NCWSC mains is branded *maji safi* (clean water*)*. These water attributes have impacted on their day-to-day consumption pattern as clean water is bought only for drinking and cooking purposes while salty water is used for cleaning activities and auxiliary purposes. Consequently, water from NCWSC is sold at a higher price (Ksh 10 per 20-litre jerrican) compared to similar quantity sourced from a borehole, which is charged at Ksh 5. Notwithstanding, underground water is exposed to contamination as the area uses on-site sanitation systems (septic tanks and pit latrines), and depletion, if left unregulated.

[36] Field interviews with a resident and NCWSC's staff in November 2016

Households that are not able to sink own wells and boreholes, nor make connections to either NCWSC or nearby boreholes majorly depend on water vendors for water supply. Water vendors also serve the local population with water during long periods of scarcity by sourcing water from elsewhere. Water vendors are mobile and deliver door-to-door water supply across the settlement. They use various modes to transport water ranging from hand carts, donkey carts, bicycles and water bowsers. Water vendors charge different prices depending on buying price at their source points, distance covered, availability of water and mode of transportation used by the vendor. Their water prices are higher compared to other means of water supply. For instance, truck vendors supply large volumes of water mostly with a capacity 10,000 litres, which costs Ksh 15,000. Small-scale vendors operate with 20-litre jerry cans and charge Ksh 10 for borehole water and Ksh 20 for NCWSC water. The customer base for truck deliveries is thus different from small-scale vendors. Mainly middle-class households, commercial enterprises such as supermarkets and big institutions with the capacity to buy and store large volumes of water use truck water delivery services. Small-scale vendors such as cart pullers serve the lower cadre who buy two to three 20-litre jerry cans of water often on a daily basis.

Largely, households, institutions and private developers complement their water supply through rain water harvesting. Most housing structures are fitted with favorable roofing materials (corrugated iron sheets), gutters and storage tanks to facilitate rain water harvesting. Households replicate these practices by installing in-house water storages. Minority group settled at the Eastern edge of Ruai and who practice agricultural activities source water from cleaner sections of the adjacent Nairobi River. This is the river where treated waste water from the sewage treatment plant is released. The river not only provides water for irrigated crop farming, but also supports auxiliary uses such as laundry and bathing.

6.4.3 Water governance in Ruai

The Ruai water landscape is shaped by a diversity of models, actors and processes. Different models ranging from a centralized system, to its multiple interaction with water trucks, hand carts and borehole distribution imply different actors and agents are involved in the process of water supply. As the case demonstrates, NCWSC is not solely in charge of governing water practices even on sections served by their mains distribution. The utility company is not able to monitor and regulate activities of their customers at the consumption point. The company does not have restrictions on per capita volume of water used as long as the consumer meets monthly bill based on meter reading. Left this way, majority of connected users use the opportunity to make extra money from onward sale of water. They determine terms and conditions of

subsequent water sales to those seeking the commodity. The company's bureaucratic application process for individual water connection also means that those who are not able to meet the requirements are disregarded and marginalized. Seen this way, the company perpetuates power inequality and elite biases creating unequal experiences of citizenship across the settlement. The economically poorer population are thus bypassed by the utility network and pushed to the margins of daily survival.

(a)On-site water selling point

(b)Mobile water conveyors

(c) Borehole water selling point

(d) Outdoor water storage

Figure 6-5: Socio-technical water assemblages in Ruai

The limits of the centralized system of governance has brought a lot of other players into the water supply chain. They range from big private developers, middle-class households and water vendors of all scales. Regardless of whether water supply is from or off the central network, these actors predominantly shape the day-to-day water practices in Ruai. The multiplicity of actors and interests has continued to affect who, where, how and what different groups get in terms of water supply. For example, whereas the localized privatized borehole scheme presents an innovative socio-technical arrangement that enhances water supply, it does not favour the economically weaker groups. The scheme requires one to raise capital for laying pipe extensions, meter equipment and storage tanks, besides a one-off deposit and maintenance fee. This option is rather expensive for the poorer social groups, locking them outside the scheme. Here, well-off social groups are seen as major beneficiaries of underground water extraction and resource capture as weaker social groups are left to the exploitation of water market forces. On the other hand, increased sinking of boreholes, if not checked, threatens sustainability of underground reservoirs for future generations. Borehole regulation is carried out by the Water Resource Management Authority (WARMA), which is a national body that issues developers with permits to drill boreholes. Although majority of borehole owners claimed to have followed the due process, ground inspection by WARMA was hardly reported. After an applicant is successfully issued with a permit to drill a borehole, there is no follow-up by WARMA officials. This partly explains why there is no official data on the number and distribution of borehole in the settlement, which would best capture the extent of ground water extraction and monitor distance between boreholes.

Not only is there inadequate water supply in Ruai, but also a lack of mechanisms for collective engagement among various actors involved in water distribution. For example, the local residents do not have a common platform from where they can mobilize themselves towards a shared water problem. This can partly be explained by the fact that those with ability to drill borehole and obtain official connection to the utility lines may not share similar problems with weaker inhabitants. This lack of a shared problem makes it difficult for residents to collectively engage water suppliers towards improved terms of water supply. As evident from my field interviews, residents were not aware of any organized community-based group and did not participate in any collective group with an aim of addressing their water problems. The village elders however indicated a strong presence of a grassroots mobilized group although majorly formed to tackle security issues in the area. The lack of synergy among different groups can be attributed to the heterogeneous socio-economic composition that characterizes Ruai's socio-demographic structure.

Yet another example is the independent operation by various water vendors. There are no laid out regulation to guide their activities. The varied and competitive interests of water suppliers in the area is typical of a free market operating with minimal state regulation. Water vendors trade water as a mode of earning livelihoods and seek to earn maximum returns from their deliveries. Notwithstanding, the quality and price of water by these vendors is not standardized across the settlement. Each vendor operates independently. Here, it is important to note that price and quality regulation is the responsibility of the Water Services Regulatory Board (WASREB)—a national public authority mandated to enforce standards in the water sector as well as protect consumers from exploitations by water service providers. However, little or no enforcement is experienced at the ground level. The laxity by WASREB on enforcing its mandate on the ground exacerbates the marginalization of the poorer social groups.

6.5 Conclusion

Peri-urban areas have remained at the periphery of urban studies as well as in core planning and infrastructure provision debates. The chapter has argued for more attention in understanding the socio-technical arrangements of peri-urban areas through the case of water supply in Ruai. More importantly, the chapter has stressed the need for seeing peri-urban areas as integral to the urban planning system. This is because socio-economic and political decisions at the core of the city directly impact on lived experience of peri-urban inhabitants. Peri-urban infrastructure thus provide a useful lens in revealing the scale and power relations involved in serving these fringe areas. It calls for a comprehensive urban infrastructure planning approaches in order to balance infrastructure benefits and promote equity in service provision.

The chapter has revealed the limitation of a centralized system of water supply especially for marginalized social groups living in the peri-urban areas. NCWSC is overwhelmed to supply adequate water to the growing and heterogeneous population living in Ruai. Rapid and unguided spatial growth have further compounded the difficulty of extending water networks into the already developed urban centre. Land speculation, conversion of land use and high-dense developments as seen in the case have gone ahead of water infrastructure provision. This case has shown that infrastructure provision intertwines with local spatial development dynamics there. Therefore, there should be coordination between the Nairobi County Government and NCWSC in the preparation and enforcement of urban plans. The central planning approach by the Nairobi County Government and NCWSC further pushes the poor population to the margins of service provision, as their economic position hampers their integration into the city's centralized network. This was

demonstrated through the bureaucratic procedure for getting water connection that was hardly achieved by poorer households. This has created unequal patterns of water supply within the settlement, leaving the poor more disadvantaged.

The case has illustrated the coexistence of diverse models of water supply devised and operated by multiple actors as a response to inadequacies of NCWSC in meeting increasing water demand in Ruai. The multiple competing interests in trading water within the settlement exert pressure on the underground water resources through drilling of boreholes. It also exploits poor residents through irregular water pricing. The lack of collective engagement among different actors, that is private developers, water vendors and different social groups make it difficult to address water problems in the area. The poor in this case continue to be disenfranchised yet with no mobilized platform to channel their dissatisfaction. The gap between the national water authorities' (WASREB and WARMA) and ground realities has widened social inequity in water supply among differentiated social groups.

This Chapter poses the question, how can multiple agency and water practices be efficiently governed to enhance water equity within peri-urban areas? There are no quick fix solutions. However, issues of price and quality of water as well as protection of aquifers can easily be addressed in the short-term to protect the most poor from exploitation. This requires enforcement of already provided national regulations by both WARMA and WASREB. On the other hand, local residents should take up the participation space provided to every citizen by the constitution and the water act to mobilize themselves for better service provision. It is only through one voice that the residents can demand for better service from the County Government and benefit from the recent developments in the area.

7. REVISITING THE NETWORKED CITY: TOWARDS "CO-HETEROGENEOUS INFRASTRUCTURE CONFIGURATIONS?"

7.1 Overview

This study sought to critique the applicability of the networked infrastructure model in the planning and development of urban water supply in fast transforming contemporary cities, such as Nairobi. To achieve this task, the study was guided by three objectives. The first was to analyze the co-evolution of the water regimes since the early formation of Nairobi to the present. This objective has been covered in Chapter Two, where I offered a post-colonial historicized account of how the ideal of the networked city was first implanted in Nairobi during the colonial era; and subsequently reinforced by the various water supply regimes in post-colonial Nairobi. I then proceeded to explicate the second objective of examining the interplay between the networked water infrastructure run by the public utility company on one hand, and the multiple non-networked water supply mechanisms fronted by a diversity of actors on the other (chapters Three through Six). Here, I engaged with a wide-range of empirical accounts to deepen our understanding of the interrelations between the various modalities of water provision across different socio-spatial topologies in Nairobi. I thus presented evidence of interrelations between the enclave privatized infrastructures, water vendors, borehole operators, technical improvisations of pressure pumps and storage containers and the public networks from selected sites of Eastleigh, Runda, Kayole Soweto and Ruai.

While each of the four cases is comprehensively covered in their own respective chapters, the current Chapter distills and brings together the key research findings in a more relational and collective discussion in Section 7.2. The key findings set a foundation for charting out what I consider a holistic and situated infrastructure lens that may help in the present and future understanding of urban diversities and heterogeneous socio-technical configurations of service provision in contemporary cities. This endeavor is undertaken in Section 7.3 and answers the third objective that I set out to achieve by way of interrogating the contradictions, complementarities and co-operation among the different water supply models. I finally close the Chapter by way of suggesting possible future research areas, in Section 7.4.

7.2 Key research findings and conclusions

In the following section, I present what I consider the key findings of this study. These findings revolve around *heterogeneity, co-production* and *marginalization* character of water infrastructure and supply modalities across the city of Nairobi.

7.2.1 From homogeneous to heterogeneous water supply configurations

Heterogeneity is evident in both the technologies and institutional arrangements that govern Nairobi's waterscape; in terms of organizations, agencies and actors mobilized in water supply. Prevailing technical artifacts consist of the publicly controlled large technical water works, privatized and decentralized treatment works, drilling of boreholes, use of pressure pumps, household storage containers, and use of different delivery means such as water trucks, hand-carts and head-loading. All these mechanisms depict heterogeneous technical (sub-)systems of water supply. Institutionally, the actors range from the state, public institutions, private actors, international financiers and development agencies, NGOs, CBOs, local communities, as well as private individuals and households. The diversity of urban actors involved in the water infrastructure and service provision also transcends various levels and cuts across various scales and levels. This means there is need to look at the interactions between the actors through a multi-level governance lens, from the lowest grassroots level to the local neighborhood, to city level, to regional level, to national level, up to the international level. Altogether, Nairobi's water supply is composed of a mix of municipal networks on one hand, and disjointed, self-driven, needs-driven and more so, profit driven water enterprises on the other hand. More explicitly, the Runda privatized supply system, the water vendors across the different parts of the city, private/communal boreholes, water containers and storage tanks in combination with the intermittent water supply from the centralized public system vividly present heterogeneous infrastructure configurations for Nairobi.

This heterogeneity has sharp conceptual implications that could be useful in redefining the way urban infrastructures have previously been theorized. Precisely, the heterogeneous landscape of water supply in Nairobi contrasts sharply with the universality, centrality and homogeneity assumptions that underpin the networked city model. After being subjected to empirical cross-examination through the lens of Nairobi's water supply, it becomes apparent that the networked city is not relatable with contexts characterized by 'stubborn realities' in both material and discursive terms (Yiftachel 2006; Watson 2012). The normative assumption of a uniform development of centralized networks governed by a monopolistic firm which also

determines consumer behavior is confronted by complex political, economic and socio-spatial dynamics that intertwine with unequal distribution of resources, rapid urbanization and power relations to reproduce unequal geographies of water supply configurations. Accordingly, the networked city model, at least in its current formulation, does not recognize the real heterogeneous socio-spatial landscapes and household needs present in cities and relying on the market logic and cost recovery principles to roll out infrastructure, locks out those with limited purchasing power (Wamuchiru and Moulaert 2017).

The imbricated mix of water supply modalities in the nation's capital can be attributed to the inability of the state and its agencies to see beyond the networked city. The persistence of multiple modalities of water supply in Nairobi indicate some sort of resistance to the 'worlding' (Roy 2011) efforts of city planners as they strive to invest in larger and larger technical systems of water supply. Closing their options to networked urbanism (Dupuy 2008), the state together with international development partners and private actors struggle to reshape the social, political, cultural, economic, environmental and spatial relations within the city to conform to an ideal of a globalized, cosmopolitan and competitive city (Shatkin 2008; 2011). The model which is reinforced through planning agents seek to orient Nairobi's urban development to 'global networks of economic exchange' (Roy 2011) against a struggling local political economy. A heterogeneous infrastructure lens however brings out the clash between the 'modern' and 'progressive' visions of the state apparatus (including the private sector, international development actors and the market) on one hand, and the 'actually existing urbanisms' (Shatkin 2011) on the other hand. This is an important perspective to consider with respect to the way African states through their planning agencies have endeavored to pursue 'networked urbanism' (Dupuy 2008) as the only form for urban water supply despite being faced by multiple grounded realities. The grounded realities have continuously contradicted the modern visions of the state and city planning authorities in achieving an integrated networked city. Neglecting the local appropriations and innovations of water technologies by the majority of urban residents is daunting to the visions, legitimacy and authority of the state planners. There is therefore need to refocus and engage with the multiple realities as a move towards transforming the way urban regimes have been previously modelled along monolithic ideals of global urbanism (Shatkin 2011).

A heterogeneous infrastructure lens, I argue, provides a better understanding of the diversities of socio-spatial manifestations and urban inequalities in infrastructure and service provision. Put in other words, there is a need to reframe the infrastructure inequalities in a different perspective in order to move from the

networked city trap, which I have argued provides a rather narrow window for understanding the complex urban phenomena in rapidly transforming cites (Furlong 2011; 2014). What the networked city does is to see the transforming cities as incomplete projects, dysfunctional, chaotic, failed, informal, not globalized and in need of solutions, in comparison to the fully developed networked cities of the West (Fourchard 2012). Yet, the multiple socio-technical water arrangements to a large extent present place-based and practical creativity, adaptability and innovations of coping with an inadequate networked water system (Jaglin 2014). In actual sense, the networked system is just but one of the many infrastructure configurations that contribute to the overall waterscape in the city.

While it is not my intention to romanticize the heterogeneous and diverse non-networked water supply modalities, I posit that they hold new possibilities either as 'incremental infrastructures' (Silver 2014) or 'mediating technologies' (Furlong 2010) in complementing the larger water supply system, if carefully considered. What is crucial here is to study and devise ideologies based on relevant contextual histories and political economy. That way, we can turn our focus to the strengths that can be harnessed from the richness of diversities we are confronted with in urban development processes other than striving to copy one universal model. The development trajectories of each city are different and this should be acknowledged as a starting point. In short, 'there is no universal way to modernize, to adopt and to adapt new technologies' (Cheneau-Loquay 2012:85). People within their cultural, traditions and localized conditions creatively respond to technologies in multiple ways to give rise to technical and institutional solutions that may produce different standards to the normative monolithic global coherence (Latour 2005; Bijker et al. 2012).

Faced with multiple yet different contextually-specific local political economies, the ideal of a networked city remains an elusive dream and gamble for Nairobi administrators. As I have demonstrated, numerous modalities of water supply operate on a day-to-day basis in meeting Nairobi's water needs. This is what constitutes the 'actually existing water urbanisms' that the state should be more keen about understanding their interactions, agencies, technology, and operations in order to holistically tap into the potentials and improve on the water problems. Put simply, a heterogeneity lens helps to widen our understanding of the existence and interplays of multiple interests, social power, modernities and forces that work in the same environment, mostly in conflicting ways, to structure, shape and produce different urban development processes using different logics and mechanisms (Watson 2003). It is the combination of all these processes that give a holistic understanding of production of different spatial practices such as multiple water practices.

Such a view helps us to recognize the heterogeneity of socio-technical realities and socio-spatial differences as fronted by diverse agencies and actors in the urban development process as well as the varied motivation behind their actions.

This Dissertation has illuminated how these multiple urbanisms are produced, negotiated and lived by different socio-economic groups within different neighborhoods of Nairobi. A finding that again points towards a need for holistic understanding of heterogeneous grounded realities. The focus on the multiplicity and interplays of the various water urbanisms disrupts the networked city model and global circulating modern ideals such as that of water privatization promoted by the state officials and their development partners. History has shown that such imported ideals only push day-to-day realities outside official policies without even interrogating or trying to understand what they are capable of bringing to the table. Perhaps the answer to the persistent water problems in Nairobi lies in uncovering the way state officials burry their heads in the sand of large technical systems of water and shoving aside needs-driven initiatives fronted by different socio-economic groups, be it individually, communally or through private arrangements.

7.2.2 From egalitarian and universal access to socio-spatial inequalities in urban water supply

The case studies have revealed critical underlying structural issues of *majinalization*[37] that influence who and which area gets (dis)connected by illuminating situated daily struggles of common residents in accessing water within different neighborhoods of the city. The implication of an over obsession by the public utility to pursue a networked infrastructure and the sidelining of some of the practical variegated configurations of water supply pushes to the margin the lowest socio-economic groups. This class of the urban population bears the brunt of water service inefficiencies, as their fate is left to market exploitations by unscrupulous water suppliers. Majority of this population lives within expanding informal settlements and peri-urban zones, areas which are often cut off from the municipal water supply network. Yet this category consists of the urban majority with the least purchasing power and weakest socio-political might to command some say in the way water is channeled to them. The Water Service Regulatory Board (WASREB) is hardly present to oversee the grounded water practices and by extension fail to protect the public from escalating price and varying quality standards. The Nairobi City Water and Sewerage Company (NCWSC) on the other hand is equally overwhelmed with the task of distributing the scarce commodity to reach the majority poor.

[37] I have used the term *majinalization* in place of the English word, marginalization. *Majinalization* is coined from the Swahili word, *Maji*, which means water. *Majinalization*, therefore, gives a stronger contextual connotation of the entrenched inequalities in the water supply landscape in Nairobi.

As expounded in Chapter two, there have been insignificantly felt improvements in the water situation by majority of Nairobi's residents despite the huge financial investments sunk in the water sector since the 1970s. The historical trajectory of Nairobi's water supply regimes reveals the entrenchment of the networked ideology that continues to enfranchise the rich while leaving a large portion of the city to invent their own coping mechanisms. The past and present experiences show that these large technical projects do not address the structural discrepancies between the oversupplied areas and underserved areas. The projects reinforce already existing inequalities in that new benefits are redirected to the mere ten percent of Nairobi's population who consume almost half of the available water supplied to the entire city (Ledant et al. 2013). This small yet powerful consumer group also determines major decisions on infrastructure investment driven by their high per capita consumption lifestyles that is linked to being 'modern' and 'progressive' (Nilsson 2016). The implication of this infrastructure development pattern can be likened to what Robert Merton termed the 'Mathew effect' of accumulated advantage. Simply put, the rich get richer while the poor get poorer.

Particularly, the politics involved in the 'upstream' (large-scale supply) and 'downstream' (distribution and payment) dynamics mars water benefits from streaming downwards (Blomkvist and Nilsson 2017). Blomkivist and Nilsson (2017) stress that regime actors in Nairobi have concerned themselves with upstream activities of financing new dam constructions, treatment works, transfer lines and new sources of water that mainly benefit the high-income group instead of expanding service distribution and integrating the large segment of the low-income population. In what they term the 'Nairobi style' of water revolution, the authors describe the water supply as sharply marked by a mismatch between the technical and institutional environment. This means the technological system is not aligned with its surroundings, institutional, physical contexts, and market and user contexts (ibid.). The upstream component seems to be the only mature part of the water system while the downstream relates to early establishment phase of the sanitary city characterized by uncertainty, segregation, social exclusions and disjointed actions (Blomkvist and Nilsson 2017). It is this mismatch between the upstream and downstream that this Dissertation has revealed through the empirical examination of the interrelations between, and fragmentation of heterogeneous configurations of water supply in different neighborhoods in Nairobi against the large technical water projects pursued by state agencies in the water sector. These forms of inequalities redefine citizenship by changing the terms of access to basic urban services, infrastructures and urban space (Allen et al. 2006; Ong 2006; Wamuchiru 2017). In agreement with what Blomkvist and Nilsson suggest, policy makers, engineers, planners and water utilities need to put more focus at the inter-level alignment and vertical integration of the downstream with the

upstream components. Overall, the plight of the urban poor is still a pressing issue in urban studies and contemporary city development. This calls for more creative ways of addressing social inequality gaps, social justice and social-spatial inclusion of all socio-economic groups in day-to-day provision of basic services.

7.2.3 From monolithic and monopolistic systems to polylithic configurations

The research findings demonstrate a repeated trait across the four cases where no single model of water supply is able to sufficiently and efficiently meet residents' water needs in isolation. This means multiple supply options co-exist side by side to complement each other. As such, the privatized decentralized systems, water vendors and individual/communal boreholes across different socio-spatial topologies in Nairobi should not be read as isolated independent configurations. They highly interact with each other in complex ways. For instance, the business and residential communities in Eastleigh survive in the interstices of the networked city. While the neighborhood has 100 percent coverage of the municipal water networks, the intermittent and low pressure forces residents to seek water supply from water vendors whose activities dominate the streets and avenues in Eastleigh. Similar occurrence was observed in Runda, which while boasting of a highly efficient and well managed private company is sometimes subjected to look for back-up services from commercial water trucks and even resort to bulk purchase of water from the public utility in order to cope with residents' demands.

A co-existence of heterogeneous supply modalities was also observed in Kayole Soweto. Even after the recent implementation of water infrastructure upgrade, the taps remain dry for the better part of the week, leaving residents to seek water services from the nearby communal borehole vending station and other modes offered by unscrupulous water vendors. The interactions of different modalities of water supply defines the day-to-day water supply practices and lived experience of residents across Nairobi. Private boreholes and the must-have storage tanks have become indispensable arrangements in filling the supply and reliance gaps left by the public utility networks. In place of the stand-alone networked infrastructure model, what we see in Nairobi is a highly interactive co-existence of variegated configurations of water provisioning that conflict with but largely complement the centralized water supply system.

The empirical discussions indeed confirm that Nairobi's water supply is a combination of efforts and resources put by the public utility on one hand, and a plethora of self-initiatives fronted and devised by individual entrepreneurs, private companies, residents associations and youth groups, to mention but a few actors.

International financiers and development actors also play prominent roles in the city's water sector not only in financing large infrastructure projects, but also in promoting Western ideologies in the water governance and technologies. Notably, the diverse actors and their agencies employ different technologies and institutional arrangements, quite often of informal repertoires, to supply water in an array of ways with each operating under their own terms without overall coordination or regulatory enforcements (see also: Kjellén and McGranahan 2006; Bakker 2008; Allen et al. 2016; Putri and Moulaert 2017). The research findings contrasts with the monolithic and monopolistic assumptions inherent in the conventional networked model. It is clear that the water infrastructure and supply modalities is made possible through co-production activities cutting through various levels of service production, operating the systems, managing the systems, distributing and supplying the water to end users. More pronounced is the role of the user as a *co-produser*[38] of the water services as opposed to the previous assumption of users as passive consumers of services.

The complex mesh of actors and institutions however present difficulties in regulating the water supply practices as well as reconciling the different power relations and interests pursued by each actor. The obscurity, association and overlap of the institutions and actors involved in the water supply business makes it difficult to mark boundaries of those involved in unscrupulous activities. The variegated modalities of water supply consequently have serious implications on public health in terms of standardization of water quality, quantity, pricing and access. The focus on water governance and lack thereof has therefore been useful in illuminating the multiplicity and complex environment under which water supply practices take place in Nairobi. Importantly, the findings bring out potentials for co-operation and co-producing urban services by way of charting a more inclusive and equitable governance structure through a co-governance lens. A co-governance lens, I argue, would help fill the institutional voids and valorize practical grassroots and decentralized infrastructure configurations. In what follows, I now present a meshed model in which I bring together the different components of heterogeneity as I discern them from the foregoing discussion.

7.3 Introducing the "CO-Heterogeneous Infrastructure Configurations" (CO-HICs) model

Despite the growing literature on infrastructures of rapidly transforming post-colonial cities in the Global South, there still exists a conceptual gap to better our understanding of the socio-technical systems there (van der Straeten and Hasenöhrl 2016). While several authors allude to a heterogeneous infrastructure configurations for cities of the Global South (for example Allen et al. 2016; Jaglin 2014; Lawhon et al. 2017),

[38] I use co-*produser* in place of co-producer to bring out the active role of users as producers of water services.

there still lacks a comprehensive situated and coherent infrastructure lens that can help us to move forward. To fill this gap, I build on the patchy and nascent ideas on 'heterogeneous infrastructures'. With the aim of fleshing out the complementarities and co-operation or contradictions between the heterogeneous infrastructures configurations, I propose a seeing of the heterogeneous infrastructure configurations through a relational conceptual triad of co-existence, co-production and co-governance. The triad relates with how the heterogeneous infrastructure configurations are co-produced, co-financed, co-managed, co-operated, co-negotiated, and co-regulated in day-to-day water supply practices in Nairobi.

My starting point is the multiple co-existence of socio-technical objects and processes in water supply for Nairobi. The analysis of the water situation are locally and spatially situated to the existing varying urban conditions in Nairobi. The cases of Eastleigh, Runda, Kayole Soweto and Ruai have been useful in demonstrating which socio-technical modalities exist, how they operate and interrelate, actors involved, for whom the different arrangements work and the motivations behind them. The analysis has also illuminated the complexities, varied risks and problematics of having to deal with multiple modalities of water supply. The variegated socio-technical modalities are configured or rather shaped by different technologies, ideologies, power relations, actors and agencies, capabilities and problems cutting through the city. No doubt this poses practical headache in terms of governance. However, the question here is, should the dominant water practices outside the official piped network continue to be treated as alternatives? Second grade? External? Informal? Temporary? How can we understand the distinct water modalities in Nairobi in a collective and relational frame that is inclusive yet represents the inherent diversities? In other words, how can we conceptually read the cases of Eastleigh, Runda, Kayole Soweto and Ruai collectively? It is no doubt the networked city is unable to provide the conceptual lens that can richly enable us to understand the breadth of water supply landscape in Nairobi. The multiple scenarios in each of the cases constitute the larger character of Nairobi's water supply. It is from these urban diversities that I propose the "CO-Heterogeneous Infrastructure Configurations" through which we can holistically understand the urban socio-technical systems of water supply in Nairobi.

7.3.1 The CO-Heterogeneous Infrastructure Configurations (CO-HICs)

As already pointed out, water vendors, storage containers, water kiosks, private boreholes, decentralized solutions, rain water harvesting and intermittent networked infrastructure all combined together dominate Nairobi's water supply. The heterogeneous infrastructure configurations have a strong conceptual and policy implication. Their visibility and interactions across the urban space are on the increase more than ever and we cannot turn a blind eye to this glaring multiple reality. It is high time we engaged in un-boxing research if we are to understand present complex urban dynamics and uproot ourselves from blindly following conventional ideologies. Hence the use of heterogeneous infrastructures to counter the long sold argument of a homogeneous, universal, monolithic and monopolistic infrastructure system that is no longer useful as an accommodative analytical lens. Heterogeneity should be the core of infrastructure investigation in contemporary cities in order to produce full and unbiased knowledge of existing socio-technical materialities without privileging one model at the expense of others. Heterogeneity implies a model that is made up of different elements. There are no alternatives or formal/informal binaries in heterogeneous arrangements. As such, heterogeneous infrastructures are different from hybrid and dual systems which have been mostly used to blur the formal and informal binaries (Coutard and Rutherford 2016; Jaglin 2016; Furlong 2014).

Fundamentally, heterogeneous infrastructures should be seen in terms of their socio-technical relations traversing the various socio-spatial dynamics in the city in a rather complex web of networks. It is for this reason that 'configurations' is a more suited term as opposed to the use of 'systems' (Jaglin 2014; Lawhon et al. 2017). Configurations, it is argued, 'decenter the often-held assumption of ordered exchanges between different and diverse technologies that act as "sub-systems"':

> Our emphasis with this term [configurations] is to examine infrastructural artifacts not as individual objects but as parts of geographically spread socio-material configurations: configurations which might involve many different kinds of technologies, relations, capacities and operations, entailing different risks and power relationship. A configuration might be thought of as the range of infrastructural options potentially available to a person for everyday use, a point which shifts us from focusing on the system-developed-from-outside towards situated-user. They shift over time; some might be available at any given moment for various reasons (functionality, finances, social relationships). Key here is not to delimit the boundaries of a configuration (which are, surely, fluid),

but the examination of different artifacts in relation to each other and social relations. (Lawhon et al. 2017: 6)

Similarly, Jaglin (2014) evokes the idea of '*delivery configuration*' (Olivier de Sardan 2010) in framing the socio-technical diversity of urban delivery channels. According to Olivier de Sardan, 'the delivery configuration of a good is the totality of actors and institutions, and of equipment and resources, which contribute to the delivery of its various components, under some form. Or other of co-production: collaboration (direct or indirect, episodic or permanent), substitution, competition, complementarity, etc.' (2010: 5-6). Broadly speaking, the idea of infrastructure configurations reflects the diverse forms of governance that emanate from individual, collective and wide-range of urban actors and institutions who operate particular standards under specific arrangements (Jaglin 2014). In the same length and breadth, I use configurations based on its rich explanatory value and broader understanding of the heterogeneous socio-technical realities in fast transforming contemporary cities.

Closely related to the foregoing, I include "CO-" in the formulation to reflect co-existence, co-production and co-governance of the heterogeneous socio-technical configurations. Hence, CO-HICs. The list can further be broken down (to include co-mplex, co-ordination, co-management, co-learning, co-designing…). However, I settle on the initial three COs as they adequately cover main conceptual elements implied by complex and interactive heterogeneous infrastructure configurations. All together, the three COs provide useful relational conceptual lens through which heterogeneous socio-technical interactions can be read collectively. The COs should be read in an interrelated manner as they are not mutually exclusive or contradictory in anyway when reading heterogeneous infrastructure configurations. I expand on each of the COs below.

7.3.1.1 Co-existence

There are conceptual and practical benefits of viewing the urban socio-technical diversities collectively. As one of the analytical lenses, co-existence broadens the spectrum by looking at the interrelations between socio-technical configurations instead of assuming one centralized integrated system which is not usually the case in rapidly transforming cities (Furlong 2014; Jaglin 2014). Co-existence shifts from the presumptions of homogenic models as black-boxed artifacts. Thus, co-existence 'not only enables an engagement with a wider variety of sociotechnical realities, it complicates the analytical utility of certain key premises in [socio-technical studies]' (Furlong 2014: 145). In real life, there is no one model of water supply that exists in

isolation. Rather, they all interplay and should be seen in relation to each other. The empirical example of Nairobi's water supply indicate that while a household might be connected to the central municipal networks, these networks interact with other socio-technical configurations. This may include storage tanks, water trucks, rainwater harvesting and door-to door deliveries, which supply water in times of water shortage. Private developers on the other hand consider drilling a borehole to serve their developments in addition to connection to the municipal mains. Their action is based on the unreliability, breakdown and unpredictable intermittent water distribution by the utility regime. The peri-urban water supply as presented in the case of Ruai demonstrates that the partial network coverage in the area allows for smaller decentralized networks around a connected user or borehole owner. Also, the infrastructures *of, for,* and *in* (refer to chapter six) as in the case of peri-urban areas imply a co-existent of variant infrastructures serving different interests and purposes. This tells of a different kind of infrastructure normalization that is characterized by the co-existence of multiple modalities of water supply, albeit in permanent flux or temporariness.

Seeing infrastructure through co-existence includes a wider variety of contexts and sociotechnical configurations (Furlong 2014). For instance, co-existence offers room for accommodating improved environmental performance of systems in the North just as much as co-existence helps to deal with improving inadequate systems in the South (ibid.). Its applicability is not restricted to water supply but could also prove to be a useful lens through which other urban infrastructures such as energy and transport services are analyzed. For instance, in Nairobi, the public transport system is made up of multiple configurations ranging from buses, *matatus* (14-seater mini-buses), *boda-boda* (passenger motorcycles and bicycles), *tuk-tuk* (three-wheeled cycles) and taxi services all of which are run by a mix of private sector and public agencies. The day-to-day operation does not follow a neat and clear-cut structure in its conduct. While the transport sector may appear chaotic to an external eye, the fact of the matter is that each of these types of arrangement serves a particular clientele and bridges a specific linkage in the entire transport chain. On the other hand, the energy landscape is composed of multiple choices of supplies and is shaped and in turn shape the consumption pattern of households. Different energy sources serve different purposes at household levels. While electricity is mostly used for lighting, LPG gas and charcoal are mostly used for cooking. These interplay with other modes such as solar energy, diesel generated energy, paraffin/kerosene lamps, candles and torches. All together, and in a co-existence perspective, these configurations constitute the energy supply.

Issues of affordability and accessibility to urban services are important factors that allow for the co-existence of varied urban services. Whereas redressing past urban inequalities is a critical task for present regimes, sustaining the accessibility and affordability of urban services by adapting the service to the demands and need of varied groups especially the highly *majinalized* in the face of high unemployment rates, vulnerabilities and variability of household income is equally an important question to address (Jaglin 2008). Users also seek co-existence to choose from a variety of sources to meet their water needs although the lived experience is especially shaped by service reliability, availability, independence, costs and consumption limits (see Meehan 2014 for Tijuana and Furlong 2013 for Medellín contexts). This we also saw in the Ruai case where residents use 'salty' borehole water for washing and cleaning purposes while the rare and more expensive 'clean' water from the municipal mains is preserved for drinking purposes. The lack of attention to users and consumption levels and patterns has been apparent in large technical systems. Moreover, 'incremental infrastructures' (Silver 2014) and 'mediating technologies' (Furlong 2010) have largely been disregarded during technology transition (Furlong 2014). It has always been expected that the networked ideal will fully replace fragmented and diverse models of providing basic services. Yet, a co-existence perspective may be helpful during this transition period by way of integration from the broader range of existing configurations as opposed to innovation, which may provide a way of knowing what may or may not work (Furlong 2014). This way, the challenges and possibilities for transiting to more equitable infrastructure configurations could be more understood than assuming a uniform outcome (ibid.).

Considering the above discussion, co-existence proves crucial in engaging with the social dimension besides the technical and economic dimensions during technological transitions (Furlong 2014). Faced with water scarcity, limited resources and socio-spatial inequalities, Nairobi's water supply must innovate in idiosyncratic ways that combine technical solutions with social realities (Srinivas and Sutz 2008). The system builders must re-evaluate their misguided quest for blanket uniformity (Nilsson 2016) and instead embed the socio-economic conditions in technological innovation especially if the needs of the majority are to be met (Srinivas and Sutz 2008). However, more coherent discourses and practices by the public institutions are needed to legitimize differentiation strategies as an equitable system of service delivery (Jaglin 2008; 2014).

By and large, co-existence can be seen as a progressive and pragmatic way of accommodating social and spatial disparities in highly polarized cities (Jaglin 2008). Taking urban diversity as a departure point, Sylvy Jaglin argues that service differentiation is a strategy to bring the diversity within the public service,

implemented through service levels and tariffs in favor of the poor. Through differentiation of urban services, institutional and financial public capacity of delivering subsidized services to the poor is preserved especially when the requisite institutional mechanisms for targeted interventions are not available (due to high costs); and when the one-size-fits-all assumption of the public service is constrained. In other words, co-existence can also be seen as a way of involving users and other third sector players as *co-produsers* of basic urban services. This turns our focus to co-governance and co-production.

7.3.1.2 Co-governance and Co-production

I propose co-governance and co-production in addition to co-existence in order to benefit from the different modes of co-operation that these two concepts hold. Other than conflictual relations, the heterogeneous infrastructure configurations present possibilities for strong co-operation that need to be harnessed to improve the larger framework of infrastructure provision and management. Analytically, co-governance and co-production pose politically-laden and power play difficulties of resolving or not resolving conflicts, friction and tensions associated with multipartite and varying socio-technical configurations in the provision of critical urban services. I acknowledge that governance of a heterogeneous infrastructure configuration will be a major hurdle in the day-to-day business of governing. What I posit is that there is more to gain than lose from the already existing multiple mechanisms.

A multiplicity of operators and service co-producers should be an accepted reality not only in the water supply but in other sectors such as waste management, sewerage disposal, transport and energy. Donors, CBOs, NGOs, and local communities altogether forge partnerships with public utilities, state actors and the private sector in the provision of public services through co-governance and co-production arrangements. The decentralized and locally situated initiatives play a critical role in urban development yet they are continuously sidelined in mainstream urban practices. It will be crucial to seek ways of improving quality of services through regulated competition, licensing, sub-contracting as well as evaluating the conditions under which such situated arrangements mitigate risks (Jaglin 2014; Lawhon et al 2017).

Far removed from urban utopia, what I am proposing here actually exists in discursive agendas of public institutions in the form of 'citizen participatory development' or 'good governance' of many international and national policy documents. For instance, the current Kenyan constitution and the water policy all provide for citizen participation in public developments but the provisions are yet to be transformed into effective day-to-

day governance practices. In earlier discussions, I highlighted how drilling of boreholes go on without enforcement yet there exists a national water institution, WARMA that should be regulating borehole practices. The licensing and pricing of water on the other hand is also well articulated by the WASREB, yet weak enforcement by the institution leaves residents to the vagaries of market exploitation. These are but few examples of how good governance approaches have for long remained at normative levels and mainly on paper without being put to actual practice. It is high time these provisions are put to practice to better understand the real challenges and potentials for co-governance and co-production in urban service provision.

From the interrelations between and among the different modalities of water supply, it is clear that grassroots actors, market actors, private actors and the state actors are not operating on mutually exclusive grounds. The day-to-day activities of drilling boreholes, water trucks, individual vendors, and kiosk operators are shaped and in turn shape the utility's water supply pattern. These interrelations provide a fertile avenue for co-governance and co-production to mediate and enforce policy provisions specifically in the weak enforcement areas of price regulation, quality control, metering of water, revenue collection and licensing of operators; as well as active participation in planning, implementing and managing water infrastructures. As such, co-governance and co-production promote negotiations for decision-making and collective management of water supply by involving active and effective participation of local communities and civil society, besides the state and private actors (Jessop 2002; Swyngedouw 2005). Emphasis should be placed on the modes of co-ordination of complex and reciprocally interdependent activities or operations (Jessop 2007).

The central idea of co-governance is to bring on board practical and useful situated socio-technical arrangements to participate in some of the activities of the public water utility. Co-governance entails strengthening the capacities of community organizations such as the Runda Residents Associations, low-income communities in Kayole Soweto, private developers and youth groups to mention but a few social actors involved in the water supply business in different parts of the city. Co-governance allows for creatively designed institution for water supply that reinforces both the state and society through inclusion of citizenry as a whole in the activities of the government (Ackerman 2004). Active engagement of relevant actors in decision making processes no doubt is with politics and all parties involved should be aware of the conflict-laden and time consuming process of institutional design. However, this should be seen as a worthwhile

project to engage with since voices from below will always rise at certain junctures. This could be through demonstrations, legal action, or even massive grassroots mobilization or if need be 'insurgent urbanisms' (Miraftab and Wills 2005; Holston 1998; Holston and Appadurai 2003) if neglected for long. While all governance modes are prone to failures for example we have experienced state failure, market failure, collective action failure or self-organization failure (Jessop 2007), effective co-governance may promise new modality in transforming the business-as-usual operations of conventional actors in the water supply.

Embracing co-governance has benefits of increasing accountability and countering socio-spatial exclusions in provision of basic urban services. There is evidence from literature that co-governance indeed can be applied in improving service delivery in a variety of contexts. For instance, Ackerman (2004) explores several case studies drawn from Brazil, Mexico, the United States and India where co-governance was used in the areas of poverty reduction, infrastructure provision, school reforms, electoral administration and police reform. A good example cited by several authors is that of participatory budgeting in Porto Alegre, Brazil (for example, de Sousa Santos 1998; Novy and Leubolt, 2005; Wampler 2010; Marquetti et al. 2012). In Porto Alegre, common citizens at the neighborhood, district and citywide levels were involved directly in the planning and supervision of public spending to increase accountability and ensure fair distribution of resources. This is a good illustration of how decentralization under the devolved government systems can function to enhance access of urban services to the majority poor by counteracting entrenched inequalities in new devolved units of administration (Fung and Wright 2001). In such a structure, state capture by the business elite and wealthy interests is limited through popular participation, which outshines the power of money with the power of voice (Ackerman 2004).

More crucially, co-governance emphasizes on multi-scalar relations from the smallest unit of a neighborhood through to the city and regional level. The multi-scalar relations should be embedded within the larger political economy and socio-spatial dynamics to allow for long-term empowerment of marginalized groups (Moulaert et al. 2010). An improved co-ordination of activities between and among the various water institutions from the grassroots level to the international arena may reduce current redundancies and overlaps in the water sector. While this introduces complexities of bureaucracies, a well thought out bureaucracy with clearly defined roles and responsibilities may go a long way in improving multi-scalar co-ordination and knowledge exchanges through vertical and horizontal linkages. The focus here is on the coordination of an 'ordered plurality' through a combination of differentiation and social redistribution (Furlong 2014). In such a multi-

scalar relations, knowledge exchange and learning experiences are transferrable and scalable to effective levels especially in promoting institutionalizing and valorizing decentralized and innovative ideas.

Fundamentally, the governance process stresses significant participation of excluded communities and democratic leadership in policy and decision making that affects them directly (Gerometta et al. 2005; Swyngedouw 2005; Moulaert et al. 2010; Eizaguirre et al. 2012). This way, local communities actively contribute in shaping public decision making, overturning their past position as passive recipients of policies and consumers of prescribed services (Cornwall and Gaventa 2000; Midheme 2013). Co-governance can therefore take many forms of bottom-up, bottom-linked or even top-down initiatives; and may be fronted by either state institutions, private sector, local communities or the civil society. Whatever form it takes, the most important thing is to counteract the neo-liberal reforms introduced by the state and its agencies by allowing voices from below to permeate top-down decision-making traditionally represented by the state and its agency (García et al. 2015; Eizaguirre et al. 2012). However, caution should be put in the Janus-face of such frameworks which may reintroduce inequalities and power imbalances inherent in day-to-day city governance (Swyngedouw 2005). It is here that co-production proves useful.

Co-production, as comprehensively elaborated in Chapter Five, helps to intertwine the participatory planning or policy formulation with grounded actions of implementation and day-to-day management of infrastructure services. Essentially, co-production improves structural reforms by transforming decision-making through engaging *majinalized* communities from plan initiation through to its material realization. Co-production views all actors as stakeholders in a more diffused and fluid process of power sharing and partnerships (Bovaird 2007; Watson 2014b). The concept has been widely applicable in the areas of delivery of public services especially in water and sanitation (Banana et al. 2015; Mcgranahan 2015; Ostrom 1996). The concept is also applicable in various contexts and more so in fast transforming cities where the state and local authorities lack the requisite resources to solely provide basic public goods and services. In such contexts, it is the norm rather than exception to find mixed and unorthodox arrangements that fit into none of the standard categories as agencies interact and co-operate with one another in a diversity of ways to provide services (Joshi and Moore 2004). This resonates rather well with infrastructure landscapes characterized by heterogeneous socio-technical configurations as in the case of Nairobi. It is therefore important to harness the potential within these arrangements, which have remained undefined, informal and renegotiated. Through 'institutionalized

co-production' (Joshi and Moore 2004), the legitimacy voids that impair community initiatives, tapping of local knowledge and strengthening of social capital can be capacitated.

More importantly, co-production promotes social inclusion of poor communities through adoption of low-cost solutions and cross-subsidization of statutory connection fees as exemplified in the Kayole Soweto case. Essentially, co-production improves accessibility to services and contributes to environmental sustainability (Moretto and Ranzato 2017). Water infrastructures require large capital outlays and hence the need for cost recovery measures and efficient management of the water resources. A co-production approach however can enhance service provision to the urban poor by improving governance processes by bringing together various stakeholders from different spheres to engage locals in devising appropriate models and practical tools that significantly improve water supply (Mcgranahan 2015; Mcmillan et al. 2014). It is important to note that co-production is not limited to only poor situations. Co-production contributes to strengthening the capacities of both the state and local communities in development of trunk infrastructures. This co-productive perspective may prove useful and appropriate in the case of the Runda Water Limited and the County Government of Nairobi. Sharing a collective responsibility with a common objective triggers changes in the business as usual practices of involved stakeholders in order to arrive at the most feasible and practical means of delivering services in the context of limited budgetary allocations, control of urban development and protecting the ecology upon which water is drawn. Eventually, a win-win situation is arrived at by all parties involved. As I argued earlier, co-production is also a way of establishing new networks among different stakeholders with different capacities and knowledge that could respond creatively to todays' complex urban problems.

7.3.1.3 Summary of CO-HICs

In figure 7-1 below, there are three dynamic arrows that interlink the various components of the CO-HICs model. These are the *why*, the *how* and the *wha*t. The first double-pointed arrow of *why* links the networked city with the sub-sets of marginalization mechanisms. This includes top-down infrastructure governance, socio-spatial exclusions, segregations, fragmentations, rapid urbanization and cost-recovery principles that have persistently left out weaker socio-economic groups outside the networked city. To upend these forms of infrastructure marginalization, the double-pointed arrow of *how* indicates the various kinds of mobilizations that sprout to fight against marginalization. The mobilizations are initiated by a diversity of actors, agencies and institutions ranging from international actors, state actors, civil society groups to grassroots and individual

households. The various mobilizations result into new ways of providing infrastructures by way of co-production activities that allows co-existence of various infrastructure mobilizations and co-governance mechanisms. Essentially, this gives rise to the production of a CO-Heterogeneous Infrastructure configuration represented by the *what* question. Concurrently, there is a feedback loop that links the mobilizations sub-sets with the networked city. This shows the dominant co-existence of the networked city amid various infrastructure mobilizations by multiple actors that constitute the CO-HICs.

The vertical arrow represents path-dependency and more so the historical trajectory of the co-evolution of CO-HICS. This arrow is important in situating the infrastructure lens within its contextual specificities. On the horizontal plane, the multi-scalar dynamics are represented to demonstrate how the various socio-technical configurations transcend various levels in the day-to-day provision of infrastructure services such as water.

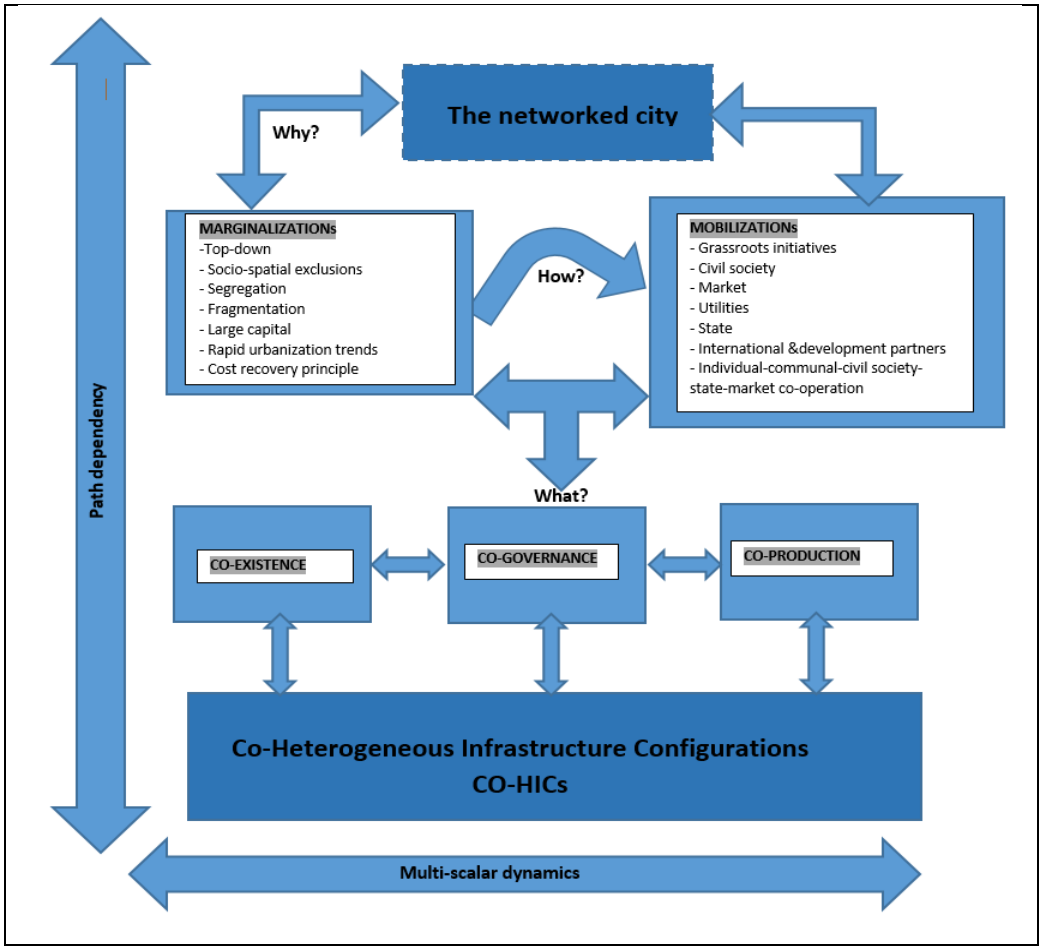

Figure 7-1: The CO-HICs analytical framework

7.3.1.4 Analytical potentials of CO-HICs

The foregoing discussion has refocused our understanding of the different infrastructure arrangements presently dominating water supply in fast transforming contemporary cities such as Nairobi. It is clear that the future is not oriented towards a universal networked system. Rather, the future is shaped by 'infrastructural archipelagos' (Bakker 2003) that require in-depth inquiry to fill the lacuna between every day and lived practices on one hand, and large technical planning shaped by abstracted practices of planning on the other hand (Allen et al. 2016). The infrastructural archipelagos closely resonates with the CO-HICs expounded in the foregoing sections. The heterogeneous future is revealed by the effects of global restructuring processes in the urban networked infrastructure systems of both the Global North and South alike. CO-HICs can therefore be useful as a normative and analytical lens through which contemporary city fragmentation, socio-spatial disintegration, exclusions and inclusions, as well as urban diversity and heterogeneous socio-technical arrangements can collectively and holistically be understood. In other words, CO-HICS offers conceptual departure points away from the networked city towards holistic understanding or rather (re)interpreting, (re)conceptualizing and (re)reading contemporary cities and their diverse infrastructure configurations by taking cognizance of the larger socio-political and economic dynamics that shape such cities.

CO-HICs bring the centrality of interaction of human actions and technical models of service provision in shaping and being shaped by technology (Bijker et al. 2012). People give meaning to infrastructures and therefore incorporating users and their local knowledge into infrastructure design helps to comprehend which socio-technical systems work for whom, how and where in the urban space. In other words, CO-HICs reconsiders 'people as infrastructures' particularly the *majinalized* urban residents who largely mobilize local resources in providing for and reproducing life in the city (Simone 2004). The connections between the social and technical change should however be understood as shaped by power relations. Put simply, the availability and unavailability of infrastructures in different socio-spatial landscapes is a physical articulation of the uneven distribution of power and opportunity in society (Swyngedouw 2009). It should also be noted that people are in flux and ever in motion in search for better opportunities that translates to improved access to urban infrastructural services. In the same way, actors in the water supply sector transcend various levels, scales and institutional spaces in the quest to provide water services to quench thirsty urban residents. This fluid and flexible 'permanent temporariness' goes against rigid, uniform, hierarchical and separation of water actors, agencies and institutions. Instead, it reveals interdependence, diversity and dynamic interaction that

needs to be understood in order to improve co-ordination and co-operation among the various actors. In fact, more effort should be directed towards forging conflict resolution mechanisms since collaboration seem not to be the larger problem here.

Yet another analytical potential of the CO-HICs is its embeddeness within the larger political economy through a historical prism. In brief, CO-HICs is path dependent. The path notion, however, incorporates theoretical possibility of multiple paths, co-existence and path interactions (Bergek and Onufrey 2013). The technological path dependency of water configurations as revealed in this Dissertation is not restricted to unitary progression patterns. Although networked urbanism has been historically institutionalized and reinforced under various water regimes, several socio-technical models of water supply have also persisted in parallel or in interaction with the centralized system. Therefore, A CO-HICS lens is more suited to analyzing the multiple techno-social paths of water configurations to better understand the water supply landscape in a more holistic manner. Essentially, the CO-HICs links the *why*, *how* and *what* questions pursued throughout this Dissertation (figure 7-1).

As in any other models, I do not presume that the proposed CO-HICs is without limitations. The key potential of the CO-HICs model lies in its core strength of representing an all-encompassing complex socio-technical interactions. Put in other words, the framework proposed remains vague in the question of how heterogeneous infrastructure configurations can be changed to fit into the mainstream regime or how the mainstream regime can be changed to fit heterogeneous socio-technical relations. And it is on the basis of this unclarity that I identify and recommend future research areas that could steer further applicability of the CO-HICs in analyzing contemporary urban infrastructure systems.

7.4 Future research recommendations

The study has illuminated fundamental and urgent issues that are relevant not only in contributing to the larger urban scholarship on infrastructure, but also for practical application by urban administrators, planners, engineers, policy makers, utilities, private sector institutions, users, the state and its agencies, international financiers, donors and development actors involved in the urban development processes. There are both governance and technical issues that will require further inquiry in order to arrive at a change-oriented practice. To begin with, special attention is needed at the critical interface—the socio-political gap between the regime and unconnected users at the local level in order to understand relevant actors, subsystems and

day-to-day water operations (Blomkvist and Nilsson 2017). These resonate with the multiple grounded situations covered in this research that manifest diverse subsystems of water supply devised by different actors, groups, institutions and individuals. These actors traverse various subsystems to constitute the day-to-day water operations yet they remain largely outside or rather in 'gray spaces' (Yiftachel 2009b) of the official system. Yet these actors have featured in the urban water supply for more than five decades, supplying water to far-off located settlements and in times of network malfunctions. Whereas the policies provide spaces for pro-poor innovations and citizen participation, these provisions are hardly enforced in practice. As such, important grassroots actors and their roles have been existing in a state of 'permanent temporariness' (Yiftachel 2009a), which neither allows for their integration, formalization or extinction. Their manifestations is a continuous reminder and a reflection of the reproduction of colonial exclusionary policies on indigenous population and their cultural practices. These modalities if well captured by sound policy measures can prove to be beneficial in filling in the gap left by official water utilities.

Secondly, there is a felt need to review the conservative forces, political aspirations, attitudes and ideals of the policy makers, minority political and socio-economic elites, donors and development actors for possible changes in the water sector. These actors including engineers, planners, technocrats and high-level administrators have undermined prospects for change, adaptation and innovation in Africa's urban water systems as they preserve and self-produce technological paradigm in line with modernity and progress ideals in every new water project (Nilsson 2016.). Together, the high-level actors plan without reference to the downstream local situation (Blomkvist and Nilsson 2017). This has led to a state of 'technological closure' (Nilsson 2016), whereby other smaller technologies are pushed aside and only the large technical system seems to be the only technological option for African cities. For instance, pro-poor and inclusive frameworks receive the least attention in capital projects (Watson 2016) while low-cost and simpler technological solutions seemingly, conflict with 'modern' and 'progress' ideals of political leaders (Blomkvist and Nilsson 2017). Usually, international experts and infrastructure financiers bring their experience from external contexts and prescribe similar solutions regardless of local contextual differences. The state in turn receives these models as they are without adapting them to fit within the local contexts. Yet, it has been severally pointed out that cultural and historical experiences are context specific and would therefore require proper adaptation and modification of foreign policies before they are situated locally (Lawhon et al. 2014). Little change is also observed in institutional reforms based on borrowed global circulating ideologies. Such ideologies now based on neoliberalism perpetuate same old discriminatory norms and practices under new

outfits (K'Akumu 2006; Nyanchaga 2016; Sambu and Tarhule 2013). As such, formal actors have become the 'unseeing state' meanwhile as they continue to view their worlds through the lenses of western modernity (Nilsson 2016). It will therefore important to conduct a research that unravels the motivations behind such skewed aspirations, visions and ideals of policy makers and planning agencies.

Thirdly, I call for more situated empirical examinations of heterogeneous infrastructure configurations in contemporary cities in order to reveal more about their co-production, co-existence, and co-governance. Future studies should reflect more on methodological approaches especially in line with promoting comparative urbanism to seek new geographies and cultures of theorizing the urban (Robinson 2016). New contextual understandings drawn from cities across the Globe will be a sure way of bringing closer the conversation across the urban divides of the north-south, south-south and north-north urbanisms. Comparative studies situated in the specific contexts is necessary to bring forward urban diversities and multiple paths that may intersect, converge, diverge or overlap. This will eventually set a new agenda for a more suited global urban studies on technological paths and how technology intersects with various societies to produce diverse outcomes as opposed to coherent universal outcomes.

CO-Heterogeneous Infrastructure Configurations have wide implication in terms of governance. Although there have been voluminous literature on governance in urban studies, there are still enormous problems experienced in areas of governance. This calls for more research on the subject. Dealing with multiple technological artifacts, users and *co-prod-users* means a complicated business affair that would require flexibility and more dynamic approaches in the way of governing structures as opposed to previous clear cut boundaries between the state, the market and civil society. The role of power relations and politics of governing heterogeneous socio-technical realities should be embedded contextually away from normative democratic citizenship discourses. There are rich local nuances that complicate the achievement of equitable outcomes and social democracy in infrastructure provision. It will therefore be important to follow up on such nuances especially on topics such as hydropolitics of water supply. For instance, a focus on the complexities of small and highly connected local groups who control water supply especially among informally developing areas would be useful in this subject area. Such groups have been referred as water cartels in the Nairobi context while in some other cities they have been referred as water mafias. The influence of 'vote-bank politics' (Benjamin 2008) on water supply promises and lack thereof especially during and after election times is also another area that could form interesting study in illuminating water governance problematics. Such

are governance nuances that I have not tackled in this Dissertation yet they represent critical nuances that can illuminate the complexity of water supply in a city like Nairobi.

Last but not least, I recommend more nuanced studies on the gendered role in the urban water supply system. I touched briefly on this aspect in the empirical chapters for example in Eastleigh where it was clear that gender roles and religion beliefs intersect with water supply problems in the area. An ethnography of how culture and social norms at household level influence water usage and how in turn this is affected by water scarcity can help us to better understand micro-level and daily lived experience of different households. This will be particularly useful in extending the analysis on inequalities based on social differentiation by demonstrating how water practices are productive of specific urban subjectivities while complicating the commonly used lens of water distribution and access tied to power and inequality (Truelove 2011).

In the upshot, future research should focus more on the critical and locally situated junctures that promise new possibilities and hold unexplored answers to some of the water problems in the city both in governance and technical areas. Unless more concerted effort and political will is redirected to these ground realities and local socio-spatial contexts, we are more likely soon to hear of the return of 'white elephant' projects upon completion of the latest water project, the Northern Collector Tunnel, as was the case with pilot showcase projects of the 1970-80s (Nilsson 2016).

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APPENDICES

Appendix A: Research Authorization Letters

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone: +254-20-2213471,
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9th Floor, Utalii House
Uhuru Highway
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No.

Date: 11th June, 2015

NACOSTI/P/15/9057/5668

Elizabeth Kanini Wamuchiru
University of Nairobi
P.O Box 30197-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Beyond the networked city: The role of communities in water infrastructure provision in Nairobi and Dar Es Salaam,"*** I am pleased to inform you that you have been authorized to undertake research in **Nairobi County** for a period ending **6th April, 2018.**

You are advised to report to **the County Commissioner and the County Director of Education, Nairobi County** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.

SAID HUSSEIN
FOR: DIRECTOR-GENERAL/CEO

Copy to

The County Commissioner
Nairobi County.

COUNTY COMMISSIONER
NAIROBI COUNTY
P. O. Box 30124-00100, NBI
TEL: 341666

The County Director of Education
Nairobi County.

COUNTY DIRECTOR OF EDUCATION
NAIROBI
17 FEB 2016

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8 April 2015

Department of Urban Planning (FG Stadt)
Urban Design and Development Unit (est)
El. Lissitzky Str. 1
64287 Darmstadt

Dear Pro. Dr. Ing. Annette Rudolph Cleff,

RE: AUTHORITY TO CARRYOUT RESEARCH - ELIZABETH KANINI WAMUCHIRU

Reference is made to your letter dated 7th April 2015 on the above mentioned subject.

Approval is hereby granted for Elizabeth Kanini Wamuchiru to do research on Water Distribution. All findings/information on Company matters should be accorded utmost confidentiality. By a copy of this letter, the Operations and Maintenance Manager, and Training and Change Management Coordinator are requested to give all the necessary support.

Kindly submit a report of your research project upon completion to the office of the undersigned.

① Received on 07/03/2016

George Okech
For: Director Human Resource and Administrative Services

Appendix B: Fieldwork Instruments

Case study one: **Eastleigh, Nairobi**

Declaration: All information collected herein shall solely be used for academic purposes. Your assistance will be highly appreciated.

Questions for the residents

1. How long have you been living in Eastleigh?
2. What reasons led you to settle in Eastlegh?
3. Where did you live before coming to Eastleigh?
4. Do you own the land/house in which you live in?
5. If not, what is the tenure status?
6. If yes, how did you acquire the property?
7. How do you obtain water on a daily basis?
8. Is/are the above mentioned water supply sufficient? Please explain.
9. How much do you pay for your water supply?
10. What are the main water issues that you face in Ruai?
11. Have there been any water improvement projects in the area?
12. If yes, kindly explain the project.
13. Were you involved in the project? If yes please explain your roles in the project.
14. How has the mentioned project benefited you?
15. Are you satisfied with the current status of the water supply in Eastleigh? Please explain.
16. What are some of the ways which can help to improve the water supply in Eastleigh?
17. Are there any residents' initiatives towards improving the water supply in Eastleigh? Please mention them.
18. Are you involved in any communal activities in improving water supply? Please explain
19. Are you aware of the Eastleigh Community Resident Association and Eastleigh Business District Association?
20. If yes, are you a participant?
21. What are the roles of the two mentioned associations?
22. Have the activities of the two associations brought about improvements in the living conditions of people here?
23. What recommendations do you have for the improvement of water supply in Eastleigh?

Questions for the Eastleigh Community Residents Association (ECRA)

1. When was the ECRA formed?
2. What are the reasons for its formation?
3. What are the functions/roles of the ECRA?
4. Whose interest do you represent?
5. Who are the members of the ECRA?
6. How does one become a member of the ECRA?
7. What development activities do you conduct in Eastleigh?
8. How do you engage the local residents in your activities?
9. How do you relate with the County Government of Nairobi?
10. Are you satisfied with the infrastructure development/provision in Eastleigh?
11. If not, why?
12. What steps have you taken to address the infrastructure problems you experience in Eastleigh?
13. What visions do you pursue for Eastleigh?
14. What recommendations do you have to make Eastleigh a better place?

Thank you!

Case study two: **Runda, Nairobi**

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Questions for the Runda Residents Association

1. When was the Runda Residents Association formed?
2. What led to the formation of the Residents Association?
3. What are the objectives of the Residents Association?
4. What is your day-to-day activities as a Residents Association?
5. What does it take to become a member of the association?
6. Are all residents members of the association? Please explain your answer.
7. How has Runda developed over time and space?
8. Are there any by-laws and rules/regulations that govern residents' activities that are specific of Runda?
9. What are the development guidelines for Runda area? Who enforces such guidelines?
10. Are you involved in the development of infrastructure projects within Runda? Please state the infrastructure projects.
11. Which partners do you work with in implementing infrastructure projects (e.g water) within your area?
12. How do you involve Runda residents in the association's activities?
13. How can you describe the interaction between your association and the Nairobi City County; and the Nairobi City Water and Sewerage Company?
14. What milestones have you achieved so far since the operationalization of the association?
15. What development challenges do you face in your neighbourhood?
16. What lessons have you learnt so far in dealing with urban issues facing your area?
17. Do you have any strategic document, annual reports or any other relevant document that contains useful information on the association and its activities? Kindly share a copy.
18. What recommendations do you suggest in improving the welfare of Runda residents?
19. Kindly share your closing remarks.

Questions for the Runda Water Limited

1. When was the Runda Water Limited formed?
2. Kindly explain the procedure of starting up and registering the RWL.
3. What are the reasons that led to the formation of RWL?
4. Who are the initial and current owners of the RWL?
5. Where does RWL get its finances from?
6. Who are the stakeholders of the RWL?
7. How is the RWL organized structurally? (i.e company organogram).
8. How do you relate with the Runda Residents Association?
9. What are the main functions of RWL?
10. In regards to water supply, what model do you employ in development of the infrastructure?

11. What are the strengths and limitations of the model you employ in the water supply?
12. Where do you source your water from?
13. Please explain the processes of water abstraction from your source and subsequent processes of treatment, storage and distribution.
14. Who are your customer base?
15. How do you charge the water supplied to Runda residents?
16. Is the tariff charged by your company approved by the WSRB?
17. Is the tariff the same as used by the public water utility, the NCWSC?
18. Please explain the rationale behind your tariffs?
19. What is the total capacity of your water supply?
20. Is the water sufficient in meeting the water needs of Runda? Please explain.
21. Are there other modes of water supply existent in Runda apart from the RWL? Please explain your answer.
22. What are the challenges that you face in playing the role of water supply?
23. How do you handle the above named challenges?
24. Do you involve the residents in your operations? Please explain the role played by the residents.
25. How do you see the future of RWL in the ten, twenty years from now?
26. Do you have any working relations with the main public institutions? That is NCWSC, AWSB and the county government of Nairobi? Please describe the relationship.
27. What are your main achievements so far since your operation in Runda?
28. What areas do you wish to see improvements?
29. What are your closing marks?
30. Kindly share relevant documents that contain information about RWL.

Questions for the residents

1. How long have lived in Runda?
2. What made you chose to live in Runda?
3. Where did you live before coming to Runda?
4. Are you a member of the Residents Association? Please explain your answer.
5. What is the procedure or requirements in becoming a member of the association?
6. What are the benefits and limitations of being a member of the RA?
7. What roles do you play as a resident in the residents association?
8. Have you faced any challenges in playing your roles in regards to the membership of the association?
9. Are you satisfied with the roles played by the association? Please explain your answer.
10. How do you get water supply?
11. Is the water supply sufficient in meeting your daily needs?
12. If not, please explain the challenges you face in the water supply.
13. How do you cope with the above named challenges?
14. Are there times when you source water from other suppliers other than the RWL? Please explain.
15. Do you face any restrictions in choosing which water service provider you wish to subscribe to?
16. Please explain, the nature of restrictions if any.
17. How much do you pay for the water supply?
18. Are you comfortable with the tariff charged by the RWL?

19. What is your opinion in regards to the performance of the RWL?
20. Kindly suggest any areas for improvement.

Thank you!

Case study three: **Kayole Soweto, Nairobi**

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Questions for the area Chief

Administration background

1. What is the role of your office?
2. When was your office formed here in Kayole Soweto?
3. What are some of the top five settlement issues that you deal with?
4. How do you resolve the above mentioned issues?
5. Do you involve the local residents in your administration?
6. If yes, kindly explain how you involve the residents?
7. What are the main challenges facing Kayole Soweto?
8. What have you done so far to address the mentioned challenges?
9. Kindly mention any suggestions to improve Kayole Soweto.

Land and development history from the chief's office

1. Which year was the Kayole Soweto settlement formed?
2. Kindly explain how Kayole Soweto as a settlement came about over the years in terms of housing and infrastructure.
3. How is land currently held in Kayole Soweto? (e.g Private titles, leasehold, allotment letter?)
4. What is the approximate number of inhabitants of Kayole Soweto and how has this been changing over the years?
5. Have there been any settlement improvement projects conducted for Kayole Soweto?
6. If yes, please name the project (s).
7. Who initiated the mentioned projects?
8. Was your office involved in the project? If yes please explain your roles in the project.
9. What led to the need for the mentioned settlement improvement project?
10. What components of the settlement were improved? e.g houses, road, electricity, water and sewer.
11. How have the projects helped to improve the living conditions across the settlement?
12. Were the local residents involved in the planning and implementation of the projects? If yes, how?
13. Are you satisfied with the results of the project?
14. What are the main challenges that Kayole Soweto face?
15. What areas would you wish to improve?
16. Do you have any documentations of the history of Kayole Soweto?

Questions for Kayole Soweto residents

1. How long have you been living in Kayole Soweto?
2. What reasons led you to settle in Kayole Soweto?
3. Where did you live before coming to Kayole Soweto?

4. Do you own the land/house in which you live in?
5. If not, what is the tenure status?
6. If yes, how did you acquire the property?
7. How do you obtain water on a daily basis?
8. Is the above mentioned water supply sufficient? Please explain
9. How much do you pay for your water supply?
10. What are the main water issues that you face in Kayole Soweto?
11. Have there been any water improvement projects in the area?
12. If yes, kindly explain the project.
13. Were you involved in the project? If yes please explain your roles in the project.
14. How has the mentioned project benefited you?
15. Are you satisfied with the current status of the water supply in Kayole Soweto? Please explain
16. Are there any other water challenges that you wish to highlight?
17. Do you have any communal group initiative in the area of water supply?
18. If yes, kindly name the group initiative and the idea behind its formation.
19. When was the group formed?
20. What are the objectives of the group?
21. Are you a member of the named group?
22. How are you involved the group's activities?
23. Do you work with other groups or institutions? Please explain how.
24. What are some of the ways which can help to improve the water supply in the settlement?

Questions for the Nairobi City Water and Sewerage Company, Kayole Soweto site office

1. When did you establish the site office here at Kayole Soweto?
2. What reasons led you to establish a site office in Kayole Soweto?
3. What are the roles of your site office?
4. How do you functionally relate with the headquarter offices at Kariobangi and industrial area?
5. How many employees do you have here at Kayole Soweto?
6. Kindly explain the professional background of your office staff?
7. What are your day to day work operations?
8. Is Kayole Soweto fully covered by the NCSWC in its water supply? Please explain your answer.
9. If no, please explain other modes of water supply for the Kayole Soweto residents.
10. How do the above modes operate?
11. Are there any water improvement project that you have implemented in Kayole Soweto?
12. When and why did you initiate the project?
13. What are the main objectives and components of the projects?
14. Who are the stakeholders involved in the project?
15. Kindly explain the roles played by each of the named stakeholder.
16. How is the project financed?
17. How many beneficiaries are you targeting at the completion of the projects?
18. How many residents so far have benefited from the project?

19. Are you satisfied with the project status? Please explain your answer.
20. Do you involve the local residents in the implementation of the project?
21. If yes, please explain how residents are involved in the project.
22. Are there any challenges that you face in the project implementation?
23. How do you intend to address the challenges?
24. Kindly give your closing remarks on the way forward for the supply of water in Kayole Soweto.
25. Please share relevant documents on your policies and projects.

Thank you!

Case study four: **Ruai, Nairobi**

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Questions for the village elders

Administration background

1. When did you become a village elder?
2. Kindly explain how you became the village elder in Ruai.
3. How long have you been a village elder here?
4. What is your role as a village elder in Ruai?
5. What are the main developmental issues facing Ruai?
6. How do you handle the above named issues?
7. What is your day to day working schedule?
8. Do you engage the local residents in your day to day administration? Please explain how?

Land and development history from the village elders

1. Which year was the Ruai settlement formed?
2. Kindly describe the type of development that was there before Ruai was settled upon.
3. Kindly explain how Ruai as a settlement came about over the years in terms of housing and infrastructure.
4. What are the factors that attract people to come and live in Ruai?
5. How is land currently held in Ruai? (e.g Private titles, leasehold, allotment letter?)
6. Please explain how land transactions are carried out in Ruai?
7. How are you involved as the village elder in the land transactions?
8. Are there any land conflicts that come as a result of the land transactions? Please explain.
9. How do the land conflicts affect development in the area?
10. How do you solve the land conflicts?
11. What are the main challenges that face inhabitants of Ruai?
12. What areas would you wish to improve?
13. Do you have any documentations that display the history of Ruai?

Questions for Ruai residents

1. How long have you been living in Ruai?
2. What reasons led you to settle in Ruai?
3. Where did you live before coming to Ruai?
4. Do you own the land/house in which you live in?
5. If not, what is the tenure status?
6. If yes, how did you acquire the property?
7. How do you obtain water on a daily basis?
8. Is/are the above mentioned water supply sufficient? Please explain

9. How much do you pay for your water supply?
10. What are the main water issues that you face in Ruai?
11. Have there been any water improvement projects in the area?
12. If yes, kindly explain the project.
13. Were you involved in the project? If yes please explain your roles in the project.
14. How has the mentioned project benefited you?
15. Are you satisfied with the current status of the water supply in Ruai? please explain
16. What are some of the ways which can help to improve the water supply in Ruai?

Questions for the Nairobi City Water and Sewerage Company, Ruai site office

1. When was your office established in Ruai?
2. What were the reasons for the establishment of your office here?
3. What are the roles of your office?
4. How do you functionally relate with the headquarter office in industrial area?
5. What are your day to day working schedule?
6. How is Ruai served with water supply from the NCWSC?
7. Is the water supply from your mains adequately meeting Ruai water needs? Kindly explain.
8. Are there other modes of water supply that exist in Ruai besides the NCWSC?
9. If yes, please describe the operation of the different modes of water supply in Ruai.
10. Are there any past, ongoing or future water projects that you have installed to improve the water situation in Ruai?
11. If yes, please explain the water projects in Ruai.
12. What are the main challenges you face in the water supply for Ruai area?
13. What recommendation would you give to improve the water supply for the area?

Thank you!

Key-Informant Interview Questions

Questions for the Nairobi City Water and Sewerage Company (NCWSC)/ Athi Water Services Board (AWSB)

1. What type of institution is the NCWSC/AWSB?
2. When was the NCWSC/AWSB formed?
3. How has the NCWSC/AWSB evolved over time to present?
4. Kindly explain the role of the NCWSC/AWSB.
5. How does the NCWSC/AWSB functionally relate with the County Government of Nairobi? Water Services Regulatory Board? Water Resources Management Authority? The national government?
6. Please explain the role played by international organizations and the working modalities between the utilities and the international organizations.
7. What are the strengths and limitations of the current organization of water institutions?
8. How can the challenges be addressed to improve the water supply in Nairobi?
9. How has the water infrastructure development evolved through time and space?
10. Kindly explain how the water supply for Nairobi is currently organized.
11. What are the challenges and benefits of the current model?
12. How do you see the future of the water supply model you employ for the Nairobi area?
13. What are the main sources of water supply for Nairobi?
14. What is the capacity of the water system?
15. Is the capacity sufficient in meeting the water needs of the Nairobi population?
16. If no, what is the current gap and what measures do you put in place to fill the gaps?
17. With the measures employed, are you then able to meet the supply/demand gap?
18. How do you address the disparity between the highly served areas and low served areas?
19. What sections of the city of Nairobi do you face more challenges in water supply? Please explain.
20. Which other modes of water supply exist in Nairobi?
21. Please explain the roles played by other modes of water.
22. What is the NCWSC/AWSB's position/opinion on the other models of water supply?
23. Specifically, how do you view the roles of Runda Water Limited?
24. What is the working modalities between your institutions and the RWL?
25. How do you relate with the other models of water? Do you issue licence for instance?
26. Do you see the need for innovate and decentralized means of water supply for Nairobi? Please explain.
27. What plans do you have in place to supply water to the informal settlements across the city?
28. Please name and explain ongoing water supply projects for the informal settlements?
29. Specifically, explain the water supply improvement projects in Kayole Soweto, Eastleigh and Ruai?
30. What are the current water situation in Kayole Soweto, Eastleigh and Ruai?
31. Kindly explain the challenges in the respective areas.
32. What strategies or improvement projects have you put in place to improve the water supply situation in the named areas?

33. Do you engage local communities in your activities? If yes, please explain the nature of engagement.
34. How do you envision the future of water supply in Nairobi?
35. What recommendation do you have for improvement of water supply?
36. Kindly share any documents that constitute relevant information on the water supply for Nairobi.

Thank you!

Questions for the Water Services Regulatory Board (WASREB)

1. What type of institution is the WASREB?
2. When did the WASREB begin operations?
3. Kindly explain the roles of the WASREB.
4. What rationales do you use to set the water tariffs for different regions and particularly for Nairobi?
5. What are the current water tariffs for Nairobi?
6. How does the WASREB functionally relate with the NCWSC? RWL?
7. How do you engage the water utility companies in your activities?
8. What are the strengths and limitations of the current organization of water institutions?
9. How can the challenges be addressed to improve the water supply for the Nairobi region?
10. Does the WASREB support other models of water supply apart from the one run by the NCWSC?
11. Do you regulate other modes of water supply? Please explain the nature of regulation and for which models.
12. How do you enforce the water regulations in different regions?
13. How do you address the disparity between the highly served areas and low served areas?
14. What areas of Nairobi face more challenges in terms of water supply?
15. What interventions do you put in place to address the above challenges?
16. Which other organizations do you work with and what role do they play?
17. What challenges do you face in your day to day running of the organization and operations?
18. Do you engage local communities in your activities? Please explain.
19. What recommendations do you have to improve the water supply for Nairobi?
20. Kindly share any documents that have information on the water supply for Nairobi and your activities generally?
21. What are your closing remarks?

Thank you!

Questions for the County Government of Nairobi

Environment and Water Department

1. What are your roles in the water infrastructure for Nairobi?
2. Which model do you use in the planning for the water supply in Nairobi?
3. What are some of the strengths and limitation of the planning model?
4. Is the model sufficient in meeting the water needs of Nairobi's population?
5. If not, what other models do you propose for the provision of water infrastructure in Nairobi?
6. What are you doing to ensure parity in the planning and provision of water across Nairobi?
7. How do you view informal settlements in terms of infrastructure development?
8. Which projects are you currently implementing to improve the water supply for Nairobi?
9. How do you co-ordinate your planning activities with the NCWSC, AWSB, WASREB and the County Government of Nairobi?
10. Are you satisfied with the current organizational structure of water provision in Nairobi?
11. What challenges do you face in working with the above named water institutions?
12. What areas of improvement do you suggest for effective working relationship?
13. Kindly share any policy and relevant documents.

Urban Housing and Development Department

1. What is the role of this department?
2. How do you co-ordinate your activites with other departments of the County Government of Nairobi and the national government?
3. What planning models do you use to plan for and control urban development in Nairobi and its surrounding?
4. Are the above planning models sufficient in urban management for Nairobi? Please explain
5. If not, what other planning interventions are you employing to manage urban development?
6. Kindly explain how Nairobi, as a city, has been developing over time and space.
7. Do you have a spatial development plan for the city? Pleas share.
8. How can you describe the relationship between the spatial development and infrastructure development?
9. Please highlight the areas which are most deprived of infrastructure services? What are the reasons for the deprivations?
10. What challenges do you face in controlling urban development across the city?
11. What is your stand point on informal settlements and infrastructure provision in such areas?
12. Please describe the urban development trends in these areas: Runda, Eastleigh, Kayole Soweto and Ruai.
13. Do you have spatial development plan that guides development in the above named areas? Please share.
14. What development challenges do you face in the named areas?

15. What is the infrastructure condition in the named areas? What explain the existing situation?
16. How do you engage the local residents in the urban development processes?
17. What interventions have you put in place to deal with development pressure on available infrastructure?
18. How do you ensure the parity between the planned and unplanned areas is ensured?
19. What areas of improvements do you suggest?
20. Kindly share the development plan for Nairobi and the named sites including the policy documents.
21. Please share some final remarks.

Thank you!

CURRICULUM VITAE

Elizabeth Kanini Wamuchiru
Department of Architecture,
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El-Lissitzky-Strasse 1
64287 Darmstadt

Elizabeth Wamuchiru is a trained and experienced urban and regional planner both in academics and field practice. Ms Wamuchiru attained her doctorate degree in October 2017 from the Faculty of Architecture, TU Darmstadt. She conducted her PhD research within the Graduate School of Urban Studies under the framework of "urban infrastructures in transition: the case of African cities". A research programme funded by the Hans Böckler Foundation. Ms Wamuchiru is a holder of an advanced Masters degree in the Science of Human Settlements from the Katholieke Universiteit Leuven, Belgium (2014); a Masters of Arts in Planning (2012) and Bachelor of Arts in Planning (2009) both from the Department of Urban and Regional Planning, the University of Nairobi, Kenya. Ms Wamuchiru also teaches at the Department of Urban and Regional Planning, University of Nairobi, Kenya. Previously, Ms Wamuchiru worked with private consultancy firms in Nairobi, where she was involved in various urban planning projects and research across cities in Kenya and Tanzania.

Publications

Wamuchiru, Elizabeth. 2017. "Beyond the networked city: situated practices of citizenship and grassroots agency in water infrastructure provision in Chamazi settlement, Dar es Salaam." Environment and Urbanization. 29 (2) 551 – 566. https://doi.org/10.1177%2F0956247817700290.

Wamuchiru, Elizabeth and Moulaert, Frank 2017. "Thinking through ALMOLIN: the community bio-centre approach in water and sewerage service provision in Nairobi's informal settlements." International Journal of Environmental Planning and Management. http://dx.doi.org/10.1080/09640568.2017.1389699